FOURTEENTH EDITION

HAND BOOK

OF

THE ELECTRIC POWER CLUB

MARCH, 1922

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OF

THE ELECTRIC POWER CLUB

1017 Olive Street
SAINT LOUIS, U. S. A.

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PREFACE

The Electric Power Club is an association of manufacturers of electric power apparatus and control equipment, organized for the standardization, improved production, and increased distribution of electrical machinery and apparatus.

This Handbook covers substantially all of the standardization thus far accomplished by The Electric Power Club and its predecessors, The American Association of Electric Motor Manufacturers, which was organized in 1908.

Sections and Committees of The Electric Power Club are actively engaged in establishing additional standards which will be published, as they are approved, in later editions of the Handbook.

Information regarding practices not covered herein may be secured by addressing The Electric Power Club, 1017 Olive St., St. Louis, U. S. A.

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THE ELECTRIC POWER CLUB
1921-1922

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R. J. Russell, President **C. H. Roth,** Vice-President.
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30 Church Street, New York City.

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6161 S. State St., Chicago, Ill.

F. M. Kimball, (Term expires 1924)
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J. F. Lincoln, (Term expires 1924)
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C. H. Roth, (Term expires 1923)
1410 W. Adams Street, Chicago, Ill.

R. J. Russell, (Term expires 1923)
1827 Pine Street, St. Louis, Mo.

H. F. Stratton, (Term expires 1922)
2700 E. 79th Street, Cleveland, O

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1921-1922

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3rd & Central Ave., Los Angeles, Cal.

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G. E. Smith.................*Associate Representative*

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W. B. Everest.....................................
.......*Assisting Freight Classifications Committee*

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F. G. Bell...................*Executive Representative*
E. G. Parvin................*Associate Representative*

CORRESPONDING SECRETARIES OF MEMBER COMPANIES.

Allen-Bradley Co.	R. Fishback
Allis-Chalmers Mfg. Co.	L. C. Nichols
American Transformer Co.	Miss N. J. Rosencrans
Automatic Switch Co.	David H. Darrin
Bell Electric Motor Co.	Thaddeus R. Bell
Bodine Electric Co.	C. D. Bodine
Burke Electric Co.	Chas. H. Schum
Century Electric Co.	R. J. Russell
Chandeysson Electric Co.	W. C. Forder
Chicago Pneumatic Tool Co.	C. B. Coates
Cincinati Electrical Tool Co.	J. Albert Goldman
Jas. Clark Jr. Electric Co.	Jas. Clark, Jr.
Cleveland Electric Motor Co	Miss Elsa W. Haaks
Condit Electrical Mfg. Co.	J. F. Taylor
Crocker-Wheeler Co.	A. L. Doremus
Cutler-Hammer Mfg. Co.	T. E. Barnum
Dayton Fan & Motor Co.	W. H. Thompson
Diehl Mfg. Co.	H. L. Zabriskie
Domestic Electric Co.	J. E. Gregory
Duncan Electric Mfg. Co.	Frederick Holmes
Eck Dynamo & Motor Co.	W. J. Wallace
Edison Storage Battery Co.	R. P. Sanborn
Electrical Development & Machine Co.	E. O. Geiler
Electric Controller & Mfg. Co.	H. F. Stratton
Electric Products Co.	T. Williams
Electric Service Supplies Co.	K. L. Kirk
Electric Storage Battery Co.	W. Van C. Brandt
Electro-Dynamic Co.	J. Farber
Electro Magnetic Tool Co.	Geo. L. Newcomb
General Electric Co.	W. C. Yates
Glow Electrical Co.	A. Glowicki
Goodman Mfg. Co.	A. B. Benedict
Gould Storage Battery Co.	M. E. Pipkin
Hisey Wolf Machine Co.	E. Ritz
Holtzer-Cabot Elec. Co.	E. R. Harding (Chicago) W. E. Haseltine (Boston)

Howell Electric Motors Co.	W. M. Spencer
Ideal Elect. & Mfg. Co.	O. H. McDaniel
Imperial Electric Co.	Guy S. Wortley
Industrial Controller Co.	F. W. Magin
Ironton Engine Co.	John E. Peters
Jantz & Leist Electric Co.	O. W. Jantz
Jeffery Mfg. Co.	J. H. Flory
Kimble Electric Co.	Jas. K. Bass
Kuhlman Electric Co.	J. A. Johnson
Lincoln Electric Co.	J. C. Lincoln
Louisville Electric Mfg. Co.	Chas. E. Willey
Marble-Card Electric Co.	J. F. Card
Mechanical Appliance Co.	H. L. Smith
Moloney Electric Co.	T. O. Moloney
Monitor Controller Co.	E. A. Ahrling
Morgan-Gardner Electric Co.	E. K. Bowers
Neil & Smith Electric Tool Company	John W. Neil
Northwestern Mfg. Co.	Frederick W. Ells
Ohio Electric & Controller Co.	A. D. Walter
Otis Elevator Co.	R. W. Gardner
Packard Electric Co.	W. F. Parker
Peerless Electric Co.	W. C. Ward
Philadelphia Storage Battery Co.	E. S. Peyton
Pittsburgh Transformer Co.	E. G. Harrington
Railway & Industrial Eng. Co.	H. H. Rudd
Reliance Elec. & Eng. Co.	C. L. Collens, 2d
Reynolds Electric Co.	Wm. L. Laib
Ridgway Dynamo & Eng. Co.	A. B. Owen
Robbins & Myers Co.	H. R. Stuart
Rochester Electric Products Corp.	Edw. F. Davison
Roth Bros. & Co.	Harry N. Gilbert
Sangamo Electric Co.	Maj. M. B. Southwick
B. F. Sturtevant Co.	C. O. Bergstrom
Temco Electric Motor Co.	J. E. Werner
Triumph Electric Co.	Justin Lebovici
Union Electric Mfg. Co.	Miss Vera Strong
U. S. Electrical Mfg. Co.	Carl E. Johnson
United States Electrical Tool Co.	C. D. Hogan
Van Dorn Electric Tool Co.	F. H. Zulauf
Wagner Electric Mfg. Co.	Miss M. L. Lawlor
Ward Leonard Elec. Co.	Alfred E. Waller
Westinghouse Elec. & Mfg. Co.	J. M. Curtin
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1921-1922

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W. C. Yates S. G. Vinson J. K. Bass

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A. H. Moore J. M. Hipple

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W. E. Haseltine

Committee References:

(a) These committees report to the Board of Governors.

(b) These committees report to the Standardization Committee.

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A. L. Doremus
J. F. Lincoln
R. J. Russell

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A. L. Doremus

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W. S. Kemp
C. C. Miner

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A. H. Moore
C. H. Roth
A. H. Timmerman

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Alternate, A. L. Doremus
Chairman, Safety Standardization Committee
(A. H. Moore)
Alternate, C. A. Mudge

Committee References:

(a) These committees report to the Board of Governors.
(b) These committees report to the Standardization Committee.
(c) Created temporarily to do special work.

SECTIONS

6000—Motor & Generator Section

A. H. Timmerman, *Chairman*
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Committees

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A. C. & D. C. Generator Committee,
J. T. Stockdale, *Chairman*

Members

Allis Chalmers Mfg. Co.
Bell Electric Motor Co.
Bodine Electric Co.
Burke Electric Co.
Century Electric Co.
Chandeysson Electric Co.
Jas. Clark, Jr., Electric Co.
Cleveland Electric Motor Co.
Crocker Wheeler Co.
Dayton Fan & Motor Co.
Diehl Mfg. Co.
Domestic Electric Co.
Eck Dynamo & Motor Co.
Electric Controller & Mfg. Co.
Electric Products Co.
Electro Dynamic Co.
General Electric Co.
Holtzer Cabot Electric Co.
Howell Electric Motors Co.
Ideal Elec. & Mfg. Co.
Imperial Electric Co.
Jantz & Leist Elec. Co.
Kimble Electric Co.
Lincoln Electric Co.
Louisville Electric Manufacturing Co.
Mechanical Appliance Co.
Marble Card Electric Co.
Northwestern Mfg. Co.
Ohio Elec. & Controller Co.
Otis Elevator Co.
Peerless Electric Co.
Reliance Electric & Engineering Co.
Reynolds Electric Co.
Ridgway Dynamo & Engine Co.
Robbins & Myers Co.
Rochester Electric Products Corp.
Roth Bros. & Co.
B. F. Sturtevant Co.
Triumph Electric Co.
U. S. Electrical Mfg. Co.
Wagner Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.
Zobell Elec. Motor Corp.

7000—Electric Tool Section

Franklin Schneider, *Chairman*
Care Van Dorn Elec. Tool Co.,
2978 Woodhill Rd., Cleveland, O.

Members

Bodine Electric Co.
Burke Electric Co.
Chicago Pneumatic Tool Co.
Cincinnati Electrical Tool Co.
Jas. Clark, Jr., Elect. Co.
Electro-Magnetic Tool Co.
Glow Elec. Co.
Hisey Wolf Machine Co.
Louisville Electric Manufacturing Co.
Neil & Smith Electric Tool Co.
Roth Bros. & Co.
Temco Electric Motor Co.
The United States Electrical Tool Co.
Van Dorn Electric Tool Co.

7800—Mining and Industrial Locomotive Section

C. H. Strawbridge, *Chairman*
Care Goodman Mfg. Co., 4834 S. Halsted St.,
Chicago, Ill.

Members

Goodman Mfg. Co.
General Electric Co.
Ironton Engine Co.
Jeffrey Mfg. Co.
Morgan-Gardner Elec. Co.
Westinghouse Electric & Mfg. Co.

8000—Industrial Control Section

H. D. James, *Chairman*
Care Westinghouse Elect. & Mfg. Co.,
E. Pittsburgh, Pa.

Members

Allen Bradley Co.
Automatic Switch Co.
Condit Electrical Mfg. Co.
Crocker Wheeler Co.
Cutler Hammer Mfg. Co.
Electric Controller & Mfg. Co.
General Electric Co.
Industrial Controller Co.
Monitor Controller Co.
Otis Elevator Co.
Union Electric Mfg. Co.
Wagner Electric Mfg. Co.
Ward Leonard Electric Co.
Westinghouse Electric & Mfg. Co.

9000—Transformer Section

M. O. Troy, *Chairman*
Care General Electric Co., Pittsfield, Mass.

Members

Allis Chalmers Mfg. Co.
American Transformer Co.
Burke Electric Co.
Duncan Electric Mfg. Co.
General Electric Co.
Kuhlman Electric Co.
Maloney Electric Co.
Packard Electric Co.
Pittsburgh Transformer Co.
Wagner Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

10,000—Power Switchboard & Switching Equipment Section

J. W. Upp, *Chairman*
Care General Electric Co., Schenectady, N. Y.

Committees

Power Switchboard Committee, *Chairman*

Oil Circuit Breaker Committee, *Chairman*

Disconnecting Switch and Bus Bar Support Committee
Chairman

Members

Allis Chalmers Mfg. Co.
Condit Electric Mfg. Co.
Electric Service Supplies Co.
Electrical Development & Mach. Co.
General Electric Co.
Railway & Industrial Engineering Co.
Westinghouse Electric & Mfg. Co.

12,000—Electric Measuring Instrument Section

(*excluding integrating meters*)
Chairman

Members

General Electric Co.
Moloney Electric Co.
Packard Electric Co.
Pittsburgh Transformer
Sangamo Electric Co.
Westinghouse Electric & Mfg. Co.

Storage Battery Section

Bruce Ford, *Chairman*
Care Electric Storage Battery Co.,
19th and Allegheny Ave., Philadelphia, Pa.

Members

Electric Storage Battery Co.

Edison Storage Battery Co.

Gould Storage Battery **Co.**

Philadelphia Storage Battery Co.

Electric Welding Section.

Electric Furnace Section.

Turbo Driven Apparatus Section.

ORGANIZATION AND METHOD OF OPERATION

1. Board of Governors.

The Board of Governors is elected by the club as prescribed in the Constitution and acts as a reference body, co-ordinating, suggesting, limiting and guiding the policies of the several standing and special committees, of the section chairmen and of the working sections.

2. Standing Committees.

Standing committees are appointed by the president, subject to the approval of the Board of Governors. Their duties call for initiative rather than participation in the minutae of development. They should co-ordinate, suggest, outline, and distribute the work to the section committees working under them, in their respective provinces. They report to the Board of Governors, and receive their general instructions from them. They receive all communications and suggestions of work to be performed, which fall within their respective provinces, and assign the work to the respective section committees for development and consummation. All reports of standing committees are subject to approval by the Board of Governors before submission to a meeting of the club.

3. Section Committees.

Section committees are appointed by each section chairman, subject to the approval of the Board of Governors, to develop and formulate such detailed rules, standards, recommendations or policies relating to the products or business of the manufacturers constituting the group as falls within their respective provinces. In each phase of their work they report to the proper standing committee having general supervision of that particular class of activity. Section committees receive the subjects to be investigated from the section chairman or from the standing committees under which they work. The section committees, however, should recognize the need of initiative and should originate work in their

respective departments, which is thought to be essential or desirable. All rules, standards, practices or policies recommended by a section committee shall be developed within the membership of the working section and presented to the club for action in accordance with the rules of procedure specified under Method of Work.

4. Section Chairmen.

A section chairman is elected by each working section as prescribed in the Constitution. He calls and presides at all meetings of his section, receives communications from the members of his section for action by the section committees or Board of Governors, co-ordinates the work of all section committees representing his section, and in general promotes the interests of the manufacturers whom he represents in their activities and relationships both within and without the club. He should develop cordial relations with all manufacturers of the particular class or classes of product embraced within his group, whether they are members of the club or otherwise, and should see that the interests of non-members are properly taken into account in all group activities. He shall furnish a list of non-member companies to the Board of Governors and shall co-operate with the Membership Committee in securing members.

5. Working Sections.

The membership of the club is divided into working sections (see pages 24-28), each section embracing all member companies who manufacture a particular class or classes of product. Under the direction of the Section Committees, detailed rules, standards, practices, etc., are developed within each working section. This may be done either by questionnaire, letter canvass, or by meetings of the working section. These meetings, as specified by the section chairman, may be either executive or general. Working Sections in all their activities are guided by policies prescribed by the Board of Governors.

6. Special Committees.

These committees investigate the special subject or work referred to them, and report thereon to the Standing Committee, officer, or Board of Governors, as the case may be, designated by the resolution creating such special committee.

7. Method of Work.

1. Subjects initiated by or referred to a section committee shall be thoroughly analyzed, studied and investigated by the section committee before final findings are submitted to the working section for approval.

2. Information desired by the Section Committee from the members of the section shall be obtained preferably by means of a questionnaire, which shall contain a brief statement of the subject under investigation, and a definite series of questions indicating clearly the information or data desired, and shall request full discussion.

3. The final findings of the Section Committee shall be in the form of a definite recommendation for insertion in the Hand Book, followed by a brief discussion indicating the arguments advanced both for and against the recommendations made, and shall be submitted in written or printed form to the working section for approval at least four weeks prior to the meeting of the club at which formal action will be requested. The committee shall in all cases indicate whether the recommendation is submitted as an Adopted Standard, Recommended Practice, or Suggested Standard for Future Design. No recommendation shall be filed by a section committee which has not received a two-thirds favorable vote of the entire membership of the working section or an unanimous vote of all members present at a meeting of the section, a majority of the entire section membership being in attendance.

4. It is recommended that the questionnaires be sent to non-members manufacturing the class of product to which the recommendation relates, and that non-members be given full opportunity to criticise and make recommendations.

5. Where the work can be facilitated thereby, called meetings of the working section may take the place of a canvass by questionnaire or letter, but in all cases the final findings must be submitted to all members of the section, including those not present at the called meeting, at least four weeks prior to the meeting of the club at which final action will be requested.

6. The final report of the Section Committee shall embody the final findings, and discussion as submitted to the working section for approval, supplemented by a list giving the names of the representatives and company affiliations of all who were given an opportunity to participate in the work of formulation, as well as of all who concurred in the final recommendation. The final report, in written or printed form, shall be filed with the proper standing committees for approval at least two weeks prior to the meeting of the club at which final action will be taken. At the time of so filing the section committees shall notify all companies opposing the recommendation of its decision, requesting each such company to immediately file a detailed statement of its objections with the Standing Committee. The statements so filed shall be attached as a minority report to the report of the Section Committee.

7. Any final report accompanied by a minority report shall be referred by the Standing Committee to the Board of Governors before it is brought before a general meeting of the club, and it shall be the duty of the Board of Governors to determine whether any injustice is done the minority in the recommendations, and to make a report of its findings to the club.

8. If approved by the proper standing committee, final reports shall be submitted to the Club for adoption.

9. In general, it is recommended that standing committees or special committees pursue the same general procedure indicated above for section committees in consummating their reports.

RULES OF PROCEDURE

In Relation to Standardization by the Electric Power Club

I. ADOPTED STANDARDS.

a. Any rule, definition, practice, basis of test, rating standard, or performance specification adopted by The Electric Power Club as a definite standard or as a definite limit shall be known as an "Adopted Standard." Three classes of Adopted Standards shall be recognized, namely: (1) Definite Fixed Standards; (2) Minimum Limits; (3) Maximum Limits.

An adopted standard of The Electric Power Club defines a practice or construction to the observance of which, in the interest of the public, all members of the Club should adhere, and in no event should a member of the Club represent as standard apparatus any material falling below such standard.

b. Adopted Standards shall be adopted only upon unanimous vote of the members present at a general meeting, following four weeks notice. The notice shall give the rule in full and shall state specifically that it is being recommended as an Adopted Standard.

c. Identification and References in the Handbook to date of adoption and date of revision shall be placed below rule in small type in the following form:

(1)—Adopted Standard.
May 3rd, 1916.

This clause shall follow all rules which are fixed standards and to be followed without variation.

(2)—Adopted Standard.
(Minimum limit)
May 3rd, 1916.

This clause shall follow all rules which are adopted as minimum limits, and if departure is made therefrom it shall be in the direction of larger values only.

(3)—Adopted Standard.
(Maximum limit)
May 3rd, 1916.

This clause shall follow all rules adopted as maximum limits, and if departure is made therefrom, it shall be in the direction of smaller values only.

d. An adopted standard may only be rescinded, following three months notice of the action proposed, by a two-thirds vote of the entire membership, or upon unanimous vote of the members present at a general meeting.

e. Apparatus complying with the adopted standards of The Electric Power Club may bear an authorized distinguishing mark to that effect.

f. It is distinctly understood that the Adopted Standards relate only to products commercially standardized and subject to repetitive and quantity manufacture, and do not apply to products built to meet the special requirements of individual customers.

II. RECOMMENDED PRACTICE.

a. Any suggestion or practice with reference to which it may be impracticable to secure full acceptance from each member of The Electric Power Club, but with reference to which it is desirable to recommend uniform practice, shall be approved and known as "Recommended Practice." Three classes of Recommended Practice shall be recognized, namely: (1) Fixed Values, (2) Minimum Limits, (3) Maximum Limits.

A Recommended Practice of The Electric Power Club defines a practice or construction which in the interest of uniformity of procedure is favored by a majority of the members of the Club.

b. Recommended Practice shall be adopted only upon two-thirds vote of the members present at a general meeting, following thirty days advance notice. Notice shall give the rule in full and shall state specifically that the rule is being submitted as Recommended Practice.

c. Identification and references in the Handbook to date of approval and date of revision shall be placed below the rule in small type in the following form:

(1)—Recommended Practice.
May 3rd, 1916.

This clause shall follow all rules adopted as fixed values of Recommended Practice, to be followed without variation.

(2)—Recommended Practice.
(Minimum limit)
May 3rd, 1916.

This clause shall follow all rules adopted as minimum limits of Recommended Practice, and if departure is made therefrom it shall be in the direction of larger values only.

(3)—Recommended Practice.
(Maximum limit)
May 3rd, 1916.

This clause shall follow all rules adopted as maximum limits of Recommended Practice, and if departure is made therefrom it shall be in the direction of smaller values only.

d. Suggestions of Recommended Practice may only be rescinded by the same action and vote as are required for rescinding an Adopted Standard.

III. SUGGESTED STANDARDS FOR FUTURE DESIGN.

a. Any rule or standard which cannot be approved either as an adopted standard or as recommended practice, but is merely recommended for future designs, shall be adopted and known as a "Suggested Standard for Future Design." Three classes of Suggested Standards for Future Design shall be recognized, namely: (1) Fixed Values, (2) Minimum Limits, (3) Maximum Limits.

b. The same notice and vote are required for Suggested Standards for Future Design as specified for Recommended Practice.

c. Suggested Standards for Future Design shall be printed on buff colored paper for the loose leaf Handbook. Identification and reference to date of approval and date of revision shall be placed below the rule in small type in the following form:

(1)—Suggested Standard for Future Design.
May 3rd, 1916.

This clause shall follow all rules adopted as fixed values of suggested Standards for Future Design to be followed without variation.

(2)—Suggested Standard for Future Design.
(Minimum limit)
May 3rd, 1916.

This clause shall follow all rules adopted as minimum limits of Suggested Standards for Future Design, and if departure is made therefrom it shall be in the direction of larger values only.

(3)—Suggested Standard for Future Design.

(Maximum limit)

May 3rd, 1916.

This clause shall follow all rules adopted as maximum limits of Suggested Standards for Future Design, and if departure is made therefrom it shall be in the direction of smaller values only.

d. Suggested Standards for Future Design may only be rescinded by the same action and vote as are required for rescinding an Adopted Standard.

IV. DEPARTURES FROM ADOPTED STANDARDS.

a. It is recognized by the members of The Electric Power Club:

(1) That the advance of the industry, the progressive development of the art of manufacturing electrical apparatus, or the rewards to which individual members are properly entitled as the result of initiative, research and invention, must not be retarded or curtailed by adopted standards to which the majority still subscribe; (2) that during a period of change or progressive development honest differences of opinion may arise over a proposed change or departure from an existing standard; and (3) that where there is reasonable evidence that such change is in the public interest, it is desirable that, while its merits are being generally demonstrated, the departure be formally recognized by The Electric Power Club as the authoritative body controlling the standardization of electrical apparatus.

b. Application for recognition in respect to a departure from the adopted standards of The Electric Power Club shall be made in writing and shall be filed with the Secretary thirty days in advance of general commercial introduction.

c. Upon favorable recommendation of the Board of Governors, approved by a two-thirds vote of the entire membership, or by an unanimous vote of all members present at a general meeting, a departure may be formally recognized.

CONSTITUTION

of

THE ELECTRIC POWER CLUB.

ARTICLE I.

Name

The name of this organization shall be The Electric Power Club.

ARTICLE II.

Objects

The objects of this organization are:

a. The discussion of subjects of interest and value to the industry in which its members are engaged.

b. The advancement and improvement of that industry.

c. The collection and dissemination of statistics and information of value to its members.

d. The standardization of electrical machinery.

e. The promotion of a spirit of co-operation among its members for the improved production and increased distribution of electrical machinery and apparatus.

ARTICLE III.

Membership

a. Membership in this club shall be limited to corporations, firms or individuals actively engaged in the manufacture of Electrical Power Apparatus and Control Equipment. Each such membership shall be known as a *member company.*

EXPLANATORY NOTE.—A prospective or accepted member of The Electric Power Club shall be considered as "actively engaged" in any given line of manufacture, within the scope of the activities covered by The Electric Power Club, constitutes a principal or important part of his output regularly and constantly produced and sold.

b. The membership of the club shall be divided into working sections, each section embracing all member companies who manufacture a specified class or closely allied classes of electrical power apparatus or control equipment. All rules and recommendations relating to the class or classes of product constituting a section shall be formulated within the working section and shall be presented to the club for adoption in

the manner prescribed from time to time by the Board of Governors, the procedure prescribed being subject to formal approval by the club. A working section may be specified or added at any time upon recommendation by a majority vote of the Board of Governors and upon approval by a majority of the entire membership of the club following one month advance notification that such action is proposed.

c. Each member company shall be entitled to one vote.

d. Each member company shall select from its organization one or more representatives whom it shall designate as its executive representative or representatives; it may select one or more whom it shall designate as associate representatives; and should the Board of Governors arrange any further classification, such member company may designate representatives for that class.

e. An executive representative shall be an executive officer of the member company or some one in its employ authorized to act for such member company.

f. An associate representative shall be an employee of a member company.

g. The Board of Governors at its discretion shall have the power to establish an additional class or classes of representatives.

h. The classification of representatives by a member company shall be subject to the approval of the Board of Governors, and it may place a limit on the number of representatives which a member company may designate for any class.

i. Representatives unavoidably absent from any meeting may be represented by proxy, said proxy to be subject to the approval of the Board of Governors.

j. Applications for membership must be made to the Board of Governors in writing on forms approved by the Board of Governors, and such forms, to be signed by the applicant, shall contain an acceptance of the Constitution and By-Laws of the Club and an obligation to abide by the same. Each applicant for membership shall secure on said application the signature of not less than two members of The Electric Power Club as sponsors. If the application is approved by the Board of Governors, it shall be submitted to the membership at the next meeting for election. Voting on applications shall be done on a written ballot. Each member company shall be entitled to one vote, and the Executive representative voting shall sign the name of his company on the ballot. A majority of the members present shall be necessary for an election.

ARTICLE IV.

a. The annual meeting and election shall be held during the months of May or June, the time and place of such meeting to be selected by the Board of Governors.

b. The management of this club shall be entrusted to a Board of Governors, composed of twelve executive representatives, no two representing the same member company, and four are to be elected each year. They shall hold office for a term of three years, except as provided by Section *c*.

c. Of the members of the Board of Governors elected at the meeting at which this amendment is adopted, or at any subsequent special election, the four receiving the highest number of votes shall serve three years, the four receiving the next highest number of votes shall serve two years, and the four receiving the next highest number of votes shall serve one year. In the event of a tie, lots shall be drawn to decide whether a candidate shall serve the three, two or one year term.

d. The officers of this club shall be a President, Vice-President, Treasurer and Secretary, who shall be elected by the Board of Governors from among their own number. The Method of Election shall be by written ballot. They shall hold their office for one year, or until their successors shall have been elected, and shall perform such duties as usually pertain to their office.

e. Seven members of the Board of Governors shall constitute a quorum.

f. In the case of a vacancy in the Board of Governors, the Board shall have the power to fill same, such member to serve until the next annual election, when such vacancy shall be filled regularly by the vote of the membership.

g. At the annual meeting of the club each working section shall by formal ballot elect a Section Chairman who is a representative of a member company entitled to membership in the section, and who shall hold office for one year, or until his successor is chosen. Each Section Chairman shall act in an advisory capacity to the Board of Governors . The Section Chairman shall preside at all group meetings, shall co-ordinate the work of all subcommittees representing his group, and in general shall promote the interest of the manufacturers whom he represents in their activities and relationships both within and without the club. The functions of Section Chairmen and the activities of all working sections shall be subject to such limitations and to such regulations as are prescribed by the Board of Governors and as are formally approved by the Club.

ARTICLE V.

Amendments

Amendments to this Constitution must be submitted in writing to the Board of Governors, and by them, with their recommendation, to the club at its next regular meeting; in order to be acted on at that time, twenty days' written notice must have been given by the secretary to each membership, stating the proposed amendment a d the recommendation of the Board of Governors. In the absence of such notice, action must be deferred until the next meeting of the club. A two-thirds vote of the entire membership shall be necessary for the adoption of any amendment.

BY-LAWS

of

THE ELECTRIC POWER CLUB

ARTICLE I.

Order of Business

1. Reading of the minutes.
2. Reports of standing committees.
3. Reports of special committees.
4. Election and resignation of members.
5. Unfinished business.
6. Communications.
7. New business.

ARTICLE II.

President

The President, or in his absence, the Vice-President, shall preside at all meetings of the club or Board of Governors. He shall appoint such standing or special committees as desired or directed, subject to the approval of the Board of Governors.

ARTICLE III.

Vice-President

The Vice-President shall perform the duties and exercise the functions of the President in the event of his absence or disability, and in the absence or disability of the Vice-President a temporary chairman may be elected by a majority vote of those present to preside at any meeting.

ARTICLE IV.

Secretary

The Secretary shall have charge of the books and papers belonging to the club, and shall keep a record of the proceedings of the club, and of the Board of Governors. He shall make and forward notifications of all meetings to each member, shall issue orders on the treasurer for payment of all bills authorized by the Board of Governors; he also shall notify new members of their election.

ARTICLE V.

Treasurer

The treasurer shall have charge of all funds of the club, collect dues, and pay bills authorized by the Board of Governors on approval of the secretary. He shall make a report on the condition of the funds at each annual meeting of the club, or as often as the Board of Governors or the club may demand.

The treasurer shall keep all funds of the club in some bank approved by the Board of Governors, and in the name of The Electric Power Club; all funds shall be subject to check of the treasurer in payment of vouchers duly approved by the secretary. He shall give such bond as may be required by the Board of Governors for the faithful performance of his duties, the premium on said bond to be paid by the club.

ARTICLE VI.

Board of Governors

The Board of Governors shall have entire control of the internal affairs of the club. It shall pass upon all applications and resignations before presentation to the club. It shall designate the place of the regular meeting unless otherwise directed by the vote of the club.

Special meetings may be called by its order, and the time and place of regular meetings fixed or changed by its direction.

ARTICLE VII.

Meetings

Meetings of the club may be either executive or general. At executive meetings only executive representatives shall be present. At general meetings only executive representatives shall vote, but all classes of representatives shall have the privilege of the floor.

ARTICLE VIII.

Dues

Each member company shall pay the sum of $50 per year for each executive representative and $15 per year for each associate representative. Should other classes be established such dues shall be payable by such classes as the Board of Governors may decide.

Annual dues shall be payable within thirty days from date of call, and if not paid within sixty days from call, non-payment shall operate automatically to cancel the membership of the delinquent, but notice of delinquency accompanied by a copy of this Section of the By-laws shall be mailed by the Secretary not less than fifteen days before cancellation of membership becomes effective.

ARTICLE IX.

Nominating Committee

A nominating committee of five executive representatives, not members of the Board of Governors and no two representing the same member company, shall be appointed by the president at least three months prior to each annual meeting. It shall be the duty of this nominating committee, at least thirty days prior to the annual meeting, to mail each executive representative a ticket bearing the names of twice as many executive representatives who have consented to serve as there are vacancies to fill. Any executive representative may make further nominations from the floor.

ARTICLE X.

Amendments

These By-Laws may be altered or amended by a majority vote of the entire membership, at any regular or called meeting, at least ten days' previous written notice having been given the membership by the secretary; or, at the discretion of the Board of Governors, a letter ballot may be taken on any proposed amendment, in which case a majority of the entire membership shall be necessary.

Roberts' Rules of Order shall be the recognized authority of parliamentary procedure.

STANDARDIZATION — FOREWORD

The co-operation existing between the Electric Power Club and the American Institute of Electrical Engineers in the field of electrical standardization is indicated by the following resolutions which have been adopted by the two organizations:

1. Resolution adopted by the Board of Directors of the A. I. E. E., April 9, 1913:

> "RESOLVED, that it is the sense of this Board that co-operation between the Standards Committee of the Institute and the Standards Committees of other national societies dealing with units and standards appertaining to or applicable in electrical engineering, or in the allied arts or sciences, is desirable, and it suggests that the Standards Committee shall take no action on any subject matter outside of the field of electrical or magnetic standardization, and within the field of the Standards Committee of another national society, before coming to an agreement with the Standards Committee of that society, provided that a reciprocal courtesy is extended by such Standards Committee of such society."

2. Resolution adopted by the Board of Governors of the Electric Power Club, May 3, 1916:

> "RESOLVED, that it is the sense of this Board that co-operation between the Standardization Committee of the Electric Power Club and the Standards Committee of the A. I. E. E. is desirable, and that the Standardization Committee of the Electric Power Club is hereby instructed to further such co-operation to the fullest extent, and in the field of commercial electrical standardization upon which this Club is engaged, to be guided by the general engineering and technical limitations established in the Standardization Rules of the A. I. E. E.; be it further
>
> "RESOLVED, that a copy of this resolution be forwarded to the Board of Directors of the A. I. E. E. in acknowledgment and acceptance of their resolution of April 9, 1913."

The line of demarkation in the standardization work of the two bodies may be briefly indicated by the following statements:

1. The preface to the Standardization Rules of the A. I. E. E. states the purpose of their work of standardization as follows:

"In framing these rules, the chief purpose has been to define the terms and conditions which characterize the rating and behavior of electrical apparatus, with special reference to the conditions of acceptance tests.

„It has not been the purpose of the rules to standardize the dimensions or details of construction of any apparatus lest the progress of design and production should be hampered."

2. Recognizing the jurisdiction of the A. I. E. E. in the field of electrical engineering and emphasizing especially its proper function in establishing such general limitations and requirements in the rating, test and performance of electrical machinery from an engineering and technical standpoint as will insure satisfactory results, it is the purpose of the Electric Power Club and the scope of the rules contained in this book:

a. To describe, classify, and define commercial types of electrical machinery, their operating characteristics and the terminology of structural details.

b. To establish commercial rating standards, such as standard voltages, load ratings, time ratings, speeds, etc.

c. Within the general engineering limitations of the Rules of the A. I. E. E., to establish the kind of rating to be used and the actual performance guarantees under which different types of electrical machinery are manufactured and sold.

d. As far as practicable, to establish standards in manufacturing practice, and in the structural details of electrical machinery.

Recognizing the desirability of co-operation in order to prevent conflict and the putting of more than one standard before the public, The Electric Power Club is willing and anxious to co-operate with other organizations interested in the standardization of electrical apparatus or in the betterment of conditions in the electrical industry.

NOTE—Wherever the rules of the A. I. E. E. are referred to in this book, the 1921 edition of the rules is used unless it is specifically stated to the contrary.

NOMENCLATURE

Reference Number

General

TYPES AS DISTINGUISHED BY FEATURES OF DESIGN.

(1001) Acid Resisting.

Apparatus so constructed that it will not be readily injured by acid fumes.

(Adopted Standard 11-18-1916.)

(1002) Drip Proof.

Apparatus so protected as to exclude falling moisture or dirt. Drip proof apparatus may be either open or semi-enclosed, if it is provided with suitable protection integral with the apparatus, or so enclosed as to exclude effectively falling solid or liquid material.

(Adopted Standard 11-18-1916.)

(1003) Dust Proof.

Apparatus so constructed or protected that the accumulation of dust will not interfere with its successful operation.

(Adopted Standard 11-18-1916.)

(1004) Dust Tight.

Apparatus so constructed that dust will not cnter the enclosing case.

(Adopted Standard 11-18-1916.)

(1005) Explosion Proof.

(1006) Gas Tight.

Apparatus so enclosed as to exclude the surrounding atmosphere. (Adopted Standard 11-18-1916.)

(1007) Moisture-Resisting.

Apparatus in which all parts are treated with moisture-resisting material. Such apparatus shall be capable of operating continuously or intermittently in a very humid atmosphere, such as that of mines, evaporating rooms, etc.

(Adopted Standard 11-18-1916.)

(1008) Splash Proof.

Apparatus protected against the entrance of a spray of water from any direction.

(Adopted Standard 11-18-1916.)

(1009) Submersible Apparatus.

Apparatus so constructed as to be capable of withstanding complete submersion in water for four hours without injury.

(Adopted Standard 11-18-1916.)

Reference
Number

(1010) Weather Proof.

Apparatus so constructed or protected that it will not be injured if exposed to the weather.

(Adopted Standard 11-18-1916.)

SERVICE CLASSIFICATIONS.

(1050) Continuous Duty.

A requirement of operation or service which demands the full rated output of the apparatus continuously.

(Adopted Standard Revised 11-18-1915.)

(1051) Intermittent Duty.

A requirement of operation or service consisting of alternate periods of load and rest so apportioned and regulated that the temperature rise at no time exceeds that specified for the particular class of apparatus under consideration.

(Adopted Standard Revised 11-18-15.)

(1052) Periodic Duty.

A requirement of operation or service demanding alternate periods of load and rest, in which the load conditions are well defined and recurrent as to magnitude, duration and character, so apportioned that the temperature rise at no time exceeds that specified for the particular class of apparatus under consideration. (Adopted Standard Revised 11-10-1915.)

(1053) Varying Duty.

A requirement of operation or service in which the apparatus is called upon to run at loads, and for periods of time, which may be subject to wide variation, but which are in no case sufficient to cause the maximum temperature rating to be exceeded. In no case shall the no load losses be sufficient to cause the maximum temperature rating to be exceeded in any part under no load continuous operation.

(Adopted Standard 5-20-1912.)

TERMS OR RATING, PERFORMANCE AND TEST.

(1060) Ambient Temperature.

The Ambient Temperature is the temperature of the air or water which, coming into contact with the heated parts of a machine, carries off its heat. (A. I. E. E. 3000.) See Reference Number 5002.

Commonly known as "Room Temperature" in connection with air cooled apparatus not provided with artificial ventilation.

(Adopted Standard 5-1-1916.)

Reference
Number

(1061) Time Rating.

The period of test run within which the specified conditions of load and mperature rise shall not be exceeded.

(Adopted Standard Revised 11-10-1915.)

Motors and Generators

GENERAL CLASSIFICATIONS.

(1110) Fractional Horse Power Motor.

A motor built on a frame smaller than that having a continuous rating of 1 H. P., open type, at 1700-1750 R. P. M.

(Adopted Standard Revised 11-10-1915.)

(1111) Large Power Motor.

A motor built on a frame having a continuous rating of 1 H. P., open type, at 1700-1750 R. P. M. or larger.

(Adopted Standard Revised 5-13-1915.)

TYPES AS DISTINGUISHED BY FEATURES OF DESIGN.

(1120) Commutating Pole Motor with Stabilizing Winding.

A shunt wound commutating pole motor with a light series winding on the main poles to give stability in speed

(Adopted Standard Revised 11-10-1915.)

(1121) Enclosed Machine.

A machine which is so completely enclosed by integral or auxiliary covers as to practically prevent the circulation of air through its interior. Such a machine is not necessarily air-tight.

(Adopted Standard 11-9-1914.)

(1122) Open Machine.

A machine of either the pedestal bearing or en r bracket type, with no restriction to ventilation othe than that imposed by its mechanical construction.

(Adopted Standard Revised 11-9-1914.)

(1123) Semi-Enclosed Machine.

A machine in which the ventilating openings in the frame are protected with wire screen, expanded metal, or perforated covers, the openings in which must not exceed ½ sq. in. in area and must be of such shape as not to permit the passage of a rod larger than ½-in. in diameter, except where the distance of live parts from the guard is more than 4-in. the openings may be ¾ sq. in. in area, but

Reference
Number
(1123 *Continued*)

must be of such shape as not to permit the passage of a rod larger than ¾-in. in diameter.

(Adopted Standard 11-9-1914.) (Amended 11-15-1921.)

(1124) Universal Motor.

A series wound or a compensated series wound motor that may be operated either upon direct current or alternating single phase current at approximately the same speed and output. These conditions must be met when the alternating current and direct current voltages are approximately the same, and the alternating current frequency is not greater than 60 cycles per second.

(Adopted Standard 11-18-1916.)

SPEED CLASSIFICATIONS.

(1170) Normal Speed.

(1171) Adjustable Speed Motor.

A shunt wound motor in which the speed can be varied gradually over a considerable range, but when once adjusted, remains practically unaffected by variation in load; for example, a motor designed for a considerable range of speed by variation in field strength. (Adopted Standard 10-20-1911.)

(1172) Adjustable Varying Speed Motor.

A motor in which the speed can be varied gradually over a considerable range, but in which the speed when once adjusted to a given load will vary in considerable degree with change in the load.

(Adopted Standard 11-9-1914.)

(1173) Constant Speed Motor.

A motor in which the speed is practically constant; for example, a synchronous motor; an induction motor with small slip; or an ordinary direct current, shun; wound, constant voltage motor.

(Adopted Standard 11-9-1914.)

(1174) Multispeed Motor.

A motor which can be operated at any one of several definite speeds, each being practically independent of the load; for example, a direct current motor with two armature windings, or an induction motor with primary winding capable of various pole groupings. (Adopted Standard 10-20-1911.)

(1175) Varying Speed Motor.

A motor in which the speed varies with the load, ordinarily decreasing as the load increases; for example, a series motor, compound motor, or series shunt motor. (Adopted Standard 11-9-1914.)

Reference
Number

SERVICE CLASSIFICATIONS.

See Reference Numbers 1050 to 1053, inclusive.

TERMS OF RATING, PERFORMANCE AND TEST.

(1190) Rated Load.

Rated Load shall mean horsepower output for motors, kilowatt output for direct current generators, and kilo-volt-ampere output for alternating current generators.

(Adopted Standard Revised 11-18-1916.)

The A. I. E. E. recommendation to give motor ratings in kilowatts is not followed, all motor ratings being given in horsepower only.

COMPLETE MACHINES AND PARTS.

(1240) Front.

In a normal motor or generator, the end opposite that at which the mechanical power is transmitted or received; usually the end of the machine at which the commutator or collector rings are found.

(Adopted Standard 10-30-1911.)

(1241) Back.

In a normal motor or generator, the end at which the mechanical power is transmitted or received; usually the end opposite to the commutator or collector rings. (Adopted Standard 10-30-1911.)

(1242) Complete Generator for Alternating Current.

(1) Belt type—consists of generator, main driving pulley, exciter driving pulley if required, sliding base or rails, and back of board field rheostat.

(Adopted Standard 5-20-1912.)

(2) Engine type—consists of generator without base, shaft or bearings, without shaft keys or foundation bolts, but with back of board field rheostat, brush rigging support and cap plates when required.

(Adopted Standard 5-20-1912.)

(3) Water wheel type—consists of generator self-contained with bearings and shaft, without sliding base or rails, without pulley or coupling, but with back of board field rheostat and exciter driving pulley when required. (Adopted Standard 5-20-1912.)

Reference
Number

(1243) Complete Generator for Direct Current.

(1) Belt type—consists of generator, sliding base or rails, and field rheostat. The field rheostats for generators above 10 kw. capacity are of the back of board type, and for generators of 10 kw. and smaller, rheostats are of the front of board type.

(Adopted Standard 5-20-1912.)

(2) Engine type—consists of generator with ut base, shaft or bearings, without shaft keys or foundation bolts, but with back of board field rheostat and cap-plates when required.

(Adopted Standard 5-20-1912.)

(1244) Complete Motor, as applied to Fractional Horse Power Motors.

A motor without sliding base or starter, but with a pulley having a single groove or one flat face.

(Adopted Standard 10-30-1911.

(1245) Complete Motor, as applied to Large Power Motors.

An open motor ready to run, including standard pulley, belt-tightening base or slide rails, and hand-operated, no voltage release starter for front of board mounting. (Adopted Standard Revised 5-20-1912.)

(1246) Bare Motor.

An open type motor ready to run, without pulley, belt-tightening base, slide rails or starter.

(Adopted Standard 10-30-1911.)

(1247) Assembled Field Frame.

A field frame with necessary complement of poles, pole shoes and field coils assembled thereon.

(Adopted Standard 10-30-1911.)

(1248) Field Frame.

The principal magnetic structure in a generator or motor including the poles when an integral part thereof, or to which they may be attached when constructed as separate pieces.

(Adopted Standard 10-30-1911.)

(1249) Field Coil.

A suitably insulated and coiled conductor through which a magnet pole of a motor or generator may be energized. (Adopted Standard 10-30-1911.)

(1250) Field Pole.

A structure of magnetic material secured to or an integral part of the field frame on which a field coil may be mounted. The pole is always located between the field frame and the armature.

(Adopted Standard 11-18-1916.)

Reference
Number

(1251) Pole Shoe.

The portion of a field magnet adjacent to the armature, whether integral with or attached to the pole. Its purpose is to secure proper distribution of the field flux. (Adopted Standard 11-18-1916.)

(1252) Assembled Bearing Bracket or End Shield.

A bearing bracket or end shield, respectively, together with its bearing sleeve and all parts associated therewith. (Adopted Standard 11-10-1915.)

(1253) End Shield.

A shield secured to the frame and adapted to support the bearing sleeve, but including no parts thereof and wholly or largely enclosing the end of the motor. (Adopted Standard 11-10-1915.)

(1254) Bearing Bracket.

A bracket of open construction secured to the frame to support the bearing sleeve, but including no parts thereof. (Adopted Standard Revised 11-10-1915.)

(1255) Assembled Bearing Pedestal.

A bearing pedestal together with its bearing sleeve and all parts accessory thereto.
(Adopted Standard 11-10-1915.)

(1256) Bearing Pedestal.

A bearing sleeve support, mounted on or constructed as a part of the base plate, but not including the bearing sleeve or any part thereof.
(Adopted Standard 11-10-1915.)

(1257) Bearing Sleeve.

The bushing, sleeve, box or shell within which the shaft rotates. (Adopted Standard 10-30-1911.)

(1258) Oil Rings.

The oil rings are usually of metal, loosely hung on the journal of an armature shaft, free to revolve thereon and therewith, located within the oil space of the bearing sleeve support and adapted to raise a lubricant from the oil cellar into which they dip to and distribute it on the journal of the shaft. (Adopted Standard 11-18-1916.)

(1259) Brush Yoke.

The rocker arm, ring, quadrant or other adjustable support for maintaining the brush studs or holders in their relative positions.
(Adopted Standard 10-30-1911.)

Reference
Number

(1260) Brush Holder.

The device that holds the brush.
(Adopted Standard 10-30-1911.)

(1261) Brush Holder Stud.

The intermediate support between brush holder and brush yoke. (Adopted Standard 10-30-1911.)

(1262) Complete Armature.

Armature ready to place in machine.
(Adopted Standard 10-30-1911.)

(1263) Armature Core.

Laminations assembled without slot insulation.
(Adopted Standard 10-30-1911.)

(1264) Armature Quill.

A ventilated or unventilated structure upon which an armature and commutator are assembled together, and which in turn may be mounted on the armature shaft.

Note: A quill may be an integral part of the armature and commutator, one or both, or the armature and commutator having been assembled separately, may be mounted together on the quill. (Adopted Standard 11-18-1916.)

(1265) Armature Shaft.

(1266) Armature Sleeve.

The unventilated support on which armature laminations are or may be mounted and which in turn is mounted on the armature shaft.
(Adopted Standard 10-30-1911.)

(1267) Armature Spider.

The ventilated support upon which armature laminations are mounted, and which in turn is mounted on the armature shaft.
(Adopted Standard 10-30-1911.)

(1268) Commutator.

An assembly of commutator bars suitably insulated in a shell or on a hub, ready for mounting on an armature shaft, sleeve or spider.
(Adopted Standard 10-30-1911.)

(1269) Commutator Bars.

The metal, current-carrying segments of a commutator. (Adopted Standard 10-30-1911.)

(1271) Commutator Insulating Rings.

All insulation between the ends of the assembled commutator bars and the ends of the supporting shell, the end opposite to the armature core being known as the front end.
(Adopted Standard 10-30-1911.)

Reference
Number

(1272) Commutator Insulating Segments.

The insulation between the sides of the commutator bars. (Adopted Standard 10-30-1911.)

(1273) Commutator Filling.

A complete assembled set of commutator bars and all insulation. (Adopted Standard 10-30-1911.)

(1274) Commutator Shell.

The metal support into which the commutator filling is assembled.
(Adopted Standard 10-30-1911.)

(1275) Slip Rings.

Rings suitably mounted on the rotating member of an alternating current machine serving with stationary brushes bearing thereon to conduct current into or out of said rotating member.
(Adopted Standard 11-10-1915.)

SINGLE PHASE MOTOR PARTS.

(1276) Split Phase Winding.

An auxiliary primary winding used in combination with the regular running winding in a single phase induction motor for the purpose of producing starting torque. (Adopted Standard 11-18-1916.)

(1277) Centrifugal Starting Switch.

A centrifugally operated automatic mechanism usually used in connection with split phase induction motors to open or disconnect the starting winding after the rotor has obtained a predetermined speed, and close or reconnect it prior to the time the rotor comes to rest. (Adopted Standard 11-18-1916.)

(1278) Centrifugal Clutch.

An automatic device often used with split phase motors which, below a predetermined speed, permits the rotating element of a motor to revolve free of the shaft, and which at that predetermined speed engages the shaft to make it turn with the rotating element and transmit the motor's power through it.
(Adopted Standard 11-18-1916.)

(1279) Short Circuiter.

A device operated by centrifugal force and used in connection with some forms of commutator type single phase motors to actuate the mechanism which short circuits the commutator bars. This short circuiter is also employed in some designs to raise the brushes from the commutator.
(Adopted Standard 11-18-1916.)

Reference Number

Industrial Control

(1500) Electric Controller.

A device, or group of devices, which serve to govern, in some predetermined manner, the electric power delivered to the device governed.

The device governed is usually a motor, but it was the intent of this definition to cover the control of generators, electric heating apparatus and any other devices requiring approximately the same kind of control as used for industrial motors.

(Adopted Standard 5-2-1916.)

(1501) Full Magnetic Controller.

A controller having all of its basic functions performed by electro-magnets.

(Adopted Standard 5-2-1916.)

(1502) Manual Controller.

A controller having all of its basic functions performed by hand. (Adopted Standard 5-2-1916.)

(1503) Semi-Magnetic Controller.

A controller having part of its basic functions performed by electro-magnets, and part by other means

By basic functions is usually meant acceleration, retardation, line closing, reversing, etc.

(Adopted Standard 5-2-1916.)

(1504) Master Switch.

A device which serves to govern the operation of contactors and auxiliary devices of an electric controller.

A master switch may be automatic, as a float switch or pressure regulator. It may be manually operated, as a drum, push button or knife switch. (Adopted Standard 5-2-1916.)

(1505) Magnetic Contactor.

A magnetically actuated device for repeatedly establishing or interrupting an electric power circuit.

(Adopted Standard 5-2-1916.)

(1506) Low Voltage Protection.

The effect of a device operative on the reduction or failure of voltage to cause and maintain the interruption of power to the main circuit.

(Adopted Standard 5-2-1916.)

(1507) Low Voltage Release.

The effect of a device, operative on the reduction or failure of voltage, to cause the interruption of power to the main circuit but not to prevent the re-establishment of the main circuit on return of voltage. (Adopted Standard 5-2-1916.)

Reference Number

(1508) Phase Failure Protection.

The effect of a device, operative on the failure of power in one wire of a polyphase circuit, to cause and maintain the interruption of power on the remaining circuits. (Adopted Standard 5-2-1916.)

(1509) Phase Reversal Protection.

The effect of a device operative on the reversal of phase relations in a polyphase circuit to cause and maintain the interruption of power in all of the circuits. (Adopted Standard 5-2-1916.)

(1510) Relay.

A device which is operative by a variation in the characteristics of one electric circuit to effect the operation of other devices in the same or another electric circuit. (Adopted Standard 5-2-1916.)

(1511) Resistance.

The opposition offered by a substance or body to the passage through it of an electric current, converting electric energy into heat; the reciprocal of conductance. (Adopted Standard 5-2-1916.)

(1512) Resistive Conductor.

A conductor which is used on account of its property of resistance. (Adopted Standard 5-2-1916.)

(1513) A Resistor.

An aggregation of one or more units possessing the property of resistance. Used in an electric circuit for the purpose of operation, protection or control of that circuit. (Adopted Standard 5-2-1916.)

(1514) Rheostat.

A resistor provided with means for varying its resistance. (Adopted Standard 5-2-1916.)

(1515) Constant Torque Resistor.

A resistor for use in the armature or rotor circuit of a motor where the current remains practically constant throughout the entire speed range. (Adopted Standard 6-11-1917.)

(1516) Fan Duty Resistor.

A resistor for use in the armature or rotor circuit of a motor where the current is approximately proportional to the speed of a motor. (Adopted Standard 6-11-1917.)

Reference
Number

(1517) Abbreviations.

The following list of abbreviations shall be approved for use in industrial control diagrams:

Armature	Arm.
Ammeter	Am.
Voltmeter	Vm.
Indicating Wattmeter	Wm.
Integrating Wattmeter	Whm.
Power Factor Meter	Pfm.
Series Field	Serf.
Shunt Field	Shf.
Resistor	Res.
Brake	Br.
Rheostat	Rheo.
Switch	Sw.
Transformer	Trans.
Push Button	P.B.
Float Switch	Fl.Sw.

(Recommended Practice 6-11-1917.)

(1518) Starter.

An electric controller designed for accelerating a motor to normal speed in one direction of rotation.

NOTE—A controller designed for starting a motor in either direction of rotation includes the additional function of reversing.

(Adopted Standard 5-23-1919.)

(1519) Automatic Starter.

A starter designed to automatically control the acceleration of a motor.

(Adopted Standard 5-23-1919.)

(1520) Overload Protection.

The effect secured by a device, operative on excessive current, to cause and maintain the interruption of current flow to the device governed. When it is a function of a controller for an electric motor the device employed shall provide for interrupting any operating overloads, but may not rupture short circuits. (Adopted Standard 5-23-1919.)

NOTE—By operating overload is meant a current not in excess of six times the rated full load current for A. C. motors or four times the rated full load current for D. C. motors.

(Adopted Standard (Maximum Limit) 11-17-1920.)

(1521) Magnet Brake.

A friction brake electro-magnetically controlled

(Adopted Standard 5-23-1919.)

Reference
Number

(1522) Wear Allowance.

The total thickness of material, which may be worn away before the contact of two associated surfaces becomes ineffective.

(Adopted Standard 5-23-1919.)

(1523) Pick-Up Voltage (or Current).

The voltage (or current) at which a magnetic contactor starts to close under conditions of normal operating temperature.

(Adopted Standard 5-23-1919.)

(1524) Sealing Voltage (or Current).

The voltage (or current) necesary to seat the armature of a magnetic contactor from the position at which the contacts first touch each other, under conditions of normal operating temperature.

(Adopted Standard 5-23-1919.)

(1525) Drop-Out Voltage (or Current).

The voltage (or current) at which the contacts of a magnetic contactor open under conditions of normal operating temperature.

(Adopted Standard 5-23-1919.)

(1526) Tight (Used as a Suffix).

Apparatus is designated as water-tight, dust-tight, etc., when so constructed that the enclosing case will exclude the specific material.

(Adopted Standard 11-17-1920.)

(1527) Resisting (Used as a suffix).

Apparatus is designated as moisture-resisting, acid-resisting, etc., when so constructed, protected or treated that it will not be readily injured when subjected to the specified material.

(Adopted Standard 11-17-1920.)

(1528) Proof (Used as a Suffix).

Apparatus is designated as splash-proof, moisture-proof, explosion-proof, etc., when so constructed, protected or treated that its successful operation is not interfered with when subjected to the specified material or condition.

(Adopted Standard 11-17-1920.)

Reference
Number

(1529) Drum Switch.

A drum switch is a switch having electrical connecting parts in the form of fingers held by spring pressure against contact segments or surfaces on the periphery of a rotating cylinder or sector.

(Adopted Standard 6-7-1921.)

(1530) Drum Controller.

A drum controller is a controller that utilizes a drum switch as the main switching element.

(Adopted Standard 6-7-1921.)

(1531) Sealing Gap.

The distance between the armature and center of the core of a magnetic contactor when the contacts first touch each other.

(Adopted Standard 6-7-1921.)

(1532) Disconnecting Switch.

A disconnecting switch means a switch which is intended to open a circuit only after the load has been thrown off by some other means.

(Adopted Standard 6-7-1921.)

(1533) Control Circuit Transformer.

A control circuit transformer is a voltage transformer utilized to supply a voltage suitable for the operation of shunt coil magnetic devices.

(Adopted Standard 11-15-1921.)

(1534) Controller Wiring Diagram.

A diagram showing the electrical connections between the parts comprising the controller, and indicating the external connections.

(Adopted Standard 11-15-1921.)

(1535) External Controller Wiring Diagram.

A diagram showing the electrical connections between the controller terminals and outside points; such as connections from the line, to the motor, and to auxiliary devices.

(Adopted Standard 11-15-1921.)

Reference
Number

(1536) Controller Construction Diagram.

A diagram indicating the physical arrangement of parts such as wiring, busses, resistor units, etc.
(Adopted Standard 11-15-1921.)

Example: A diagram showing the arrangement of grids and terminals in a grid type resistor.

(1537) Elementary Controller Diagram.

A diagram using symbols and an elementary plan of connections to illustrate, in simple form, the motor circuits and the scheme of control.
(Adopted Standard 11-15-1921.)

(1538) Control Sequence Table.

A table indicating the connecting devices that are closed for each successive position of the controller.
(Adopted Standard 11-15-1921.)

(1540) Service.

The "service" of an industrial controller means the specific application in which the controller is to be used, as for example:

(a) General purpose, which covers the occasional starting of motors.
(b) Crane and hoist.
(c) Elevator.
(d) Machine Tool.
Etc.

(Adopted Standard 11-15-1921.)

(1541) Duty.

The "duty" of an industrial controller means the specific function or functions that it is designed to accomplish in respect to the performance of the motor; such as starting, speed control, reversing and stopping, and the frequency and duration of operation. (Adopted Standard 11-15-1921.)

COMMERCIAL STANDARDIZATION

Motors and Generators

Reference
Number

GENERAL GUARANTEE.

(2001) Rated Output.

The manufacturer guarantees that apparatus manufactured by him will deliver successfully its rated output as indicated on the nameplate, provided said apparatus is properly cared for, operated under normal conditions and with competent supervision.

(Adopted Standard 11-10-1915.)

(2002) Replacement of Defective Material.

The manufacturer agrees to correct and shall have the right to correct by repair or replacement at his own expense, at his option f. o. b. his works, any defects in said apparatus which may develop under normal and proper use within six (6) months after date of shipment, when inspection proves the claims provided the purchaser gives the manufacturer immediate written notice of such defects, and provided further that during said period said apparatus is properly cared for, operated under normal condition, and with competent supervision. The correction of such defects by repair or replacement by the manufacturer shall constitute a fulfillment of all his obligations to the purchaser.

When apparatus is purchased and resold, the maximum guarantee period shall be twelve months from date of shipment from the works of the electrical apparatus manufacturer.

(Recommended Practice 11-10-1915.)

(2003) Non-Responsibility for Damaged Apparatus.

The manufacturer shall not be responsible for any damage resulting from improper storage or handling prior to placing the apparatus in service, and the manufacturer shall not assume any expense or liability for repairs made outside his works, without his written consent. (Adopted Standard 11-10-1915.)

Reference
Number

(2004) Liability for Consequential Damage.

The manufacturer shall not be liable for consequential damage in case of any failure to meet the conditions of any guarantee.

(Adopted Standard Revised 11-10-1915.)

(2005) Furnishing Keys as Part of Shafts.

All machines with keyways cut in the shaft extension for pulley, coupling, pinion, etc., shall be furnished with a key, unless otherwise specified by the customer. (Recommended Practice 11-17-1916.)

SPECIAL WORK AND TESTS.

(2006) Special Bores.

(a) Bores of armature spiders for Direct Current engine type generators, differing from Standard (See Reference Number 6673), shall be considered a proper subject for an extra charge.

(Recommended Practice 6-8-1914.)

(b) Bores of rotating members for Alternating Current engine type generators, differing from standard (See Reference Number 6773), shall be considered a proper subject for an extra charge.

(Recommended Practice 6-8-1914.)

(2007) Pressing Rotor on Engine Shaft.

It has been found good practice for the generator builder to press the engine shaft into the rotating member at his works. The charge for this work shall be included in the price of the generator and the engine builder shall include in the price of the engine the transportation charges on the shaft.

(Recommended Practice 6-8-1914.)

(2015) Witness Test.

As manufacturers have found it advisable to make regular tests before any witness test is given, witness test shall be charged for.

(Recommended Practice 5-20-1912.)

Reference
Number

Customer Specifications

(2025) Government and Other Standard Specifications.

When apparatus is built to meet the requirements of the government or other standard printed specifications, and the name plate clearly indicates the specifications to which the apparatus conforms, it is not necessary to include on the name plate the detailed information specified in The Electric Power Club rules. (Recommended Practice 6-11-1917.)

Publication Dimensions

(2501) Standard Sizes for Circulars, Contract Forms, Price Forms and Engineering Data.

8½″ x 11″ shall be used for circulars, contract forms, and such engineering data as are not intended to go with price sheets. Circulars shall be bound on the side. Contract forms and engineering data shall be bound on the end. 4″x7″ shall be used for price forms and engineering data that accompany price forms. These shall be arranged for binding on the side in ring binders.

(Recommended Practice 11-9-1914.)

Reference Number (3000)

Motor Service Rules of the N. E. L. A.

The rules governing the installation and use of motors on central station distributing systems have been endorsed as suggested practice by the Executive Committee of the National Electric Light Association, and have also been approved by the Electric Power Club. They are printed here for convenient reference:

The instantaneous current (determined by test or based on value guaranteed by manufacturer) drawn from the line by any motor (with the starting device, if any required, in the starting position) must not exceed the value for the rated horsepower of such motor as obtained from the following tables.

In a group installation the largest amount of starting current permitted by Tables "A" or "B" or "C" for any motor of the installation shall be the limit of starting current for any other motor of the group.

The limits of starting current in Table "B" are intended to be such that starting devices for polyphase motors will be required for motors above 5 H. P. where the installation consists of a single motor of such size. Instances may occur wherein it may be necessary to use a starting device on 5 H. P. motors. In any installation where starting devices are normally required, it shall be optional with the operating companies to approve the omission of the starting devices on motors of certain capacities.

Motors that cannot be safely subjected to full voltage at starting must be provided with a device to insure that on failure of voltage either

(a) The motor will be disconnected from the line, or

(b) The starting device will be returned to the starting position.

Reverse phase relays and circuit breakers or equivalent devices are recommended on all polyphase elevator installations, cranes and similar service to protect the installation in case of phase reversal.

Should special conditions seem to warrant an exception to the above rules the case must be referred to the company for consideration and decision.

Reference
Number

(3000 *Continued*)

Table "A"
Single Phase—Sixty Cycle

Maximum permissible starting current values for an installation of a single motor installed and connected to its load.

	Volts	Amperes *A	Amperes **B
½ H.P. and below................	220	15	20
Above ½ H.P. to 1 H.P. inclusive	220	20	27
		Amperes per H.P.	
Above 1 H.P. to 5 H.P............	220	15	20
‡Above 5 H.P....................	220	11	15

Motors requiring not more than *30 amperes starting current may be connected for 110 volt service.

The maximum size of a single-phase motor to be permitted on one phase of polyphase systems should be 5 H. P., larger sizes to be installed only after securing special permission.

* and ** See Notes next page.

‡When desired to install single phase motors larger than 6 H. P. inquiry must be made of the operating company to determine if singel phase current for this service is available.

Table "B"
Polyphase—Sixty Cycle

Maximum permissible starting current values for an installation of a single motor installed and connected to its load.

	Volts	2 Phase Amps. Per Phase Per H.P. *A	2 Phase **B	3 Phase Amps. Per Phase Per H.P. *A	3 Phase **B
1 H.P. and below..	220	17.3	23	20	26.7
Above 1 H.P. to 2 H.P. inclusive...	220	15.2	20	17.5	23.3
Above 2 H.P. to 5 H.P. inclusive...	220	11.2	15	13	17.3
	440	5.6	7.5	6.5	8.7
	550	4.5	6	5.2	6.9
Above 5 H.P. to 30 H.P. inclusive...	220	8	10.7	9	12
	440	4	5.4	4.5	6
	550	3.2	4.3	3.6	4.8
	2200	1	1.1	1	1.2

* and ** See Notes next page.

Reference
Number

(3000 *Continued*)

	Volts	2 Phase Amps. Per Phase Per H.P. *A	**B	3 Phase Amps. Per Phase Per H. P. *A	**B
Above 30 H.P.....	220	5.2	7	6	8
	440	2.6	3.5	3	4
	550	2.1	2.8	2.4	3.3
	2200	0.5	0.7	0.6	0.8

*Current values under A are those indicated by a suitable, well-damped ammeter in the motor circuit on the line side of the starting device for an installation of a single motor installed and connected to its load, and are 75 per cent of the permissible locked rotor values.

**Current values under B are those similarly indicated when testing a motor with the rotor locked and in case of doubt, being based on recognized values of impedances, are the ultimate standards of reference.

Table "C"
Shunt and Compound Wound Direct Current Motors

Maximum permissible starting current values for an nstallation of a single motor installed and connected to its load.

	Volts	***Amperes Per H. P.
3 H. P. and below...............	230	12
	550	5
Above 3 H. P...................	230	9
	550	4

***Current values are those indicated by a suitable well damped ammeter on the line side of the starting resistance.

No direct-current motor larger than ¾ H. P. may be connected to a 115 volt circuit.

Direct current 115 volt motors up to ½ H. P. shunt and ¾ H. P. compound wound, but in no case exceeding 30 amps. starting current, may be installed without starting resistance.

APPARATUS APPLICATION

Reference
Number

(4001) Proper Selection of Apparatus

Extreme care should be used in the proper selection of apparatus in order that satisfactory operation and good service will result. Where the apparatus is subjected to unusual risk, the engineering department of the manufacturer should be consulted; especially where the apparatus is used under the following conditions:

Exposed to acid fumes,
Operating in damp places,
Where an exceedingly high speed is required,
Exposed to flour dust,
Exposed to gritty dust,
Exposed to steam,
Operated in poorly ventilated rooms,
Operated in pits, or where entirely enclosed in boxes,

Where operating temperature of the apparatus with overload guarantees applied exceeds 90° C.

(Adopted Standard 10-30-1911.)

USE OF 40° AND 50° RATING MOTORS

The following resolutions, regarding the use of 40° and 50° rating motors, were presented to and approved unanimously by the General Meeting of The Electric Power Club in Cleveland, Ohio, Nov. 15, 1921:

> *Whereas,* The Electric Power Club has at the present time two Adopted Standards for open type continuous duty motors described in Reference Number 5303 as the 40° and the 50° Rating; and
>
> *Whereas,* during a period of progressive development of the use and application of the 50° Rating, it has been considered necessary to differentiate between the various uses and applications of the 50° Rating and to recognize as a departure the 50° Rating where sold for general purposes as distinguished from the 50° Rating when specially applied; and
>
> *Whereas,* in the judgment of The Electric Power Club this differentiation in the use and application of the 50° Rating is no longer necessary; and
>
> *Whereas,* the Purchasing Public now recognizes the two Ratings for open type machines with continuous time ratings and with proper co-operation on the part of the manufacturers and proper education can intelligently apply whatever rating in its judgment best meets the duty cycle and conditions of service to which the motor or generator is to be applied.
>
> *Now, Therefore, Be It Resolved,* that all limitations in respect to the 50° Rating as an Adopted Standard of The Electric Power Club be removed; and be it further
>
> *Resolved,* that all Member Companies request their organizations to recognize and support both the 50° rating and the 40° rating in their negotiations and activities with all other organizations in any way dealing with the subject; and be it further
>
> *Resolved,* that derated 50° motors and generators when offered as 40° motors or generators shall carry the guarantees specified under the rules of The Electric Power Club for the 40° rating.

USE OF 40° AND 50° RATING MOTIONS

GENERAL ENGINEERING RECOMMENDATIONS

Reference Number

General

(5001) Classification of Insulating Materials

Insulating materials when considered in connection with temperature limits shall be classified as follows:

Class A. Cotton, silk, paper and similar materials, when so treated or impregnated as to increase the thermal limit, or when permanently immersed in oil; also enameled wire and enameled silk or cotton covered wire.

Class B. Mica, asbestos and other materials capable of resisting high temperatures, in which any Class A material or binder is used for structural purposes only, and may be destroyed without impairing the insulating or mechanical qualities of the insulation.

Class C. Fireproof and refractory materials, such as pure mica, porcelain, quartz, etc.

(Adopted Standard 11-9-1915.)

Impregnated means that the insulating material is thoroughly saturated but that in the case of coils the spaces between conductors are not necessarily completely filled.

Enameled wire, when silk or cotton covered, falls under Class A even if the fibrous covering is not treated, as this covering may be destroyed without imparing the insulation. (See 1918 Revision A. I. E. E. Rules Nos. 375-392.)

(5002) Ambient Temperature

1. The standard ambient temperature of reference when the cooling medium is air, shall be 40° C.

See Reference Number 7815-2 for Ambient Temperature of Reference for Mining Locomotives.

The Ambient Temperature of Reference means the maximum ambient temperature at which a piece of apparatus can operate successfully under full rated conditions. If this maximum ambient temperature is exceeded and the conditions or rating produce the permissible temperature rise, the maximum permissible actual temperature will be exceeded and deterioration of insulation result. Such a condition may also obtain in any piece of apparatus when it is operated within the maximum ambient temperature of 40° C. at voltages and frequencies other than normal. (Adopted Standard Revised 11-18-1916.)

2. A machine may be tested at any convenient ambient temperature but whatever be the value of this ambient temperature the permissible rises of temperature must not exceed those specified.

Reference
Number

(5002 *Continued*)

3. No correction need be made for the deviation of the ambient temperature of the cooling medium from the standard ambient temperature of reference.
(Adopted Standard 11-9-1915.)

See A. I. E. E. Rules Nos. 305, 307, 311 and 320. In the case of rotating machines cooled by forced draft a conventional weighted mean for the ambient temperature shall be employed, a weight of four being given to the temperature of the circulating air supplied through ducts and a weight of one to the surrounding room air. (1918 Revision of A. I. E. E. Rules))

Rotating Machines

RATINGS AND TESTS.

(5300) Standards of Rating Performances and Duration of Tests.

Many machines are operated on a cycle of duty which repeats itself with more or less regularity. The heating of machines operating under such conditions is equivalent to a continuous run for a certain specified time. The standard duration of tests, or time ratings, for machines operating on such ratings shall be as follows:

5 min.
10 min.
15 min.
30 min.
60 min.
120 min.
Continuous.

Of these the first six are commonly known as Short Time Ratings. In every case the short time test shall commence only when the windings and other parts of the machine are within 5 degrees of the room temperature at the time of starting the test.
(Adopted Standard 11-9-1915.)

(See 1918 Revision A. I. E. E. Rules Nos. 284, 285 and 286.)

(5301) Temperature Measurements.

Temperatures herein referred to shall be measures by thermometer on all induction motors and on other motors and generators of less than 200 kw. or 200 H.P. output. (Adopted Standard Revised 11-9-1915.)

(5302) Overload Temperature.

The temperature of a machine when carrying overload shall be determined by starting the overload run not more than fifteen minutes after completing the test at rated load. Fifteen minutes shall be regarded as sufficient time within which to record result of rated test. (Adopted Standard.)

Reference
Number

(5303) Temperature Ratings.

1. There may be two ratings for open type motors and generators with Class A insulation and continuous time ratings as follows:

(a) A rating giving a 40-Deg. C. temperature rise guarantee under continuous operation with a two-hour, 25 per cent overload guarantee at 55 Deg. C., to be designated and known as the 40 Deg. Rating.

(b) A rating giving a 50-Deg. C. temperature rise guarantee under continuous operation without overload temperature guarantee, to be designated and known as the 50-Deg. Rating.

2. Machines having 40-Deg. Ratings are designed for all classes of service, including those in which an overload capacity of 25 per cent for two hours is desired.

3. Machines having 50-Deg. Ratings are designed for conditions in which the load requirements are accurately known, and under which the machine will not be subjected to load in excess of its rating. Other ratings without overload temperature guarantee, which are designed for these same conditions or service, are:

Type	Class of Insulation	Time Rating	Temperature Rating
Open..........	A	Any	50 Deg. C.
Semi-enclosed..	A	"	50 Deg. C.
Enclosed......	A	"	55 Deg. C.
Open..........	B	"	70 Deg. C.
Semi-enclosed..	B	"	70 Deg. C.
Enclosed......	B	"	75 Deg. C.

4. The temperature rating for which the machine is designed, including time rating and overload temperature guarantee, shall be clearly and specifically stated on all name-plates and in all bulletins, price sheets, quotations, specification sheets, etc.

(Adopted Standard 11-18-1916,
Amended 11-15-1921.)

STANDARD MANUFACTURING PRACTICE.

(5400) Tapered Shafts.

The standard taper of shafts shall be at the rate of one and one-quarter inches in diameter per foot of length. (Recommended Practice 11-9-1914.)

Reference
Number

(5401) Direction of Rotation.

The standard direction of rotation for all non-reversing direct current motors and alternating current single phase motors shall be counter clockwise, and for all alternating current and direct current generators shall be clockwise viewed from the end of the machine opposite drive.

Unless otherwise specified, standard machines will be connected for standard direction of rotation.

(Recommended Practice 11-9-1915.)

(5402) Brush Dimensions.

1. Lengths of Round and Rectangular Brushes.

To 1¼",	inclusive	Increase by	steps	of		⅛"
Over 1¼" to 3"	"	"	"	"	"	¼"
Over 3"		"	"	"	"	½"

Wherever possible ¼" steps are to be used below 1" length and ½" steps above 1" length.

2. Width and Diameter.

Up to ¼",	inclusive	Increase by	steps	of		1/16"
Over ¼" to 2½"	"	"	"	"	"	⅛"
Over 2½"		"	"	"	"	¼"
Diameter of all round brushes		"	"	"	"	1/16"

For widths ¼" steps are to be used wherever possible.

3. Thickness.

Up to ¾", inclusive	Increase by	steps	of		1/16"
Over ¾"	"	"	"	"	⅛"

Wherever possible ⅛" steps are to be used above ½" in thickness.
Diameter of round brushes shall vary by steps of 1/16".

4. Limits.

(a) Rectangular and square brushes.

Length—plus or minus 1/32".
Width—exact size to 1/64" undersize.
Thickness—
Plain brushes +.001"
−.003"
Plated brushes +.001"
−.004"

For square brushes, thickness limits to apply to both width and thickness.

Reference
Number

(5402 *Continued*)

(b) Round Brushes.

Diameter	
Up to ¼″, inclusive	Exact size to .006″ undersize
5/16″ and ⅜″ "	" " " .008″ "
7/16″ and above	" " " .010″ "

Length—plus or minus 1/32″.

Box guages to be used for thickness and diameter.

5. Length of Flexible Shunts.

The length of a flexible shunt shall be the distance from the top of the brush to the center of the slot or hole in the terminal.

6. Holes or Slots in Terminals for Flexible Shunts.

Size of Screw	Maximum Size Hole or Slot
No. 8 and No. 10	7/32″
" 12 " 14	¼″
5/16″ diameter	11/32″
⅜″ "	13/32″

Minimum size of hole or slot shall allow sufficient clearance to permit the screw entering the slot or hole without binding.

7. Bevels.

Bevels on carbon brushes shall vary by steps of 5°, and shall be accurate to within 1° above or below.

The length of a beveled brush shall be the distance from the end to the toe of the bevel, if beveled on one end only, or the distance from toe to toe measured parallel to the face of the brush when both ends are beveled. In other words, the length shall be that of the square ended brush from which the beveled brush was made.

8. Plated Brushes.

Dimensions, limits, etc., shall be the same as specified for plain brushes, except thickness limits for which see paragraph 4 above.

(Recommended Practice 11-18-1916.)

TERMINALS AND THEIR MARKING.

(5403) Motor Terminals.

Terminal connectors shall be standard for motors 5 H.P. 1750 R.P.M. up to and including 250 H.P. or 250 K.W. The use of terminal connectors on motors below 5 H. P., 1750 R.P.M., shall be optional with the manufacturer.

(Recommended Practice 11-13-1917.)

Reference
Number

(5404) Terminal Markings.

Standard Method of Terminal Marking and Connections.

These markings are used only for terminals to which connection must be made from outside circuits or from auxiliary devices which must be disconnected for Shipment. They are not intended to be used for internal machine connections.

Single, Two and Three-phase Induction Motors.
D. C. Motors.
A. C. Generators.
D. C. Generators.
Transformers.
Control

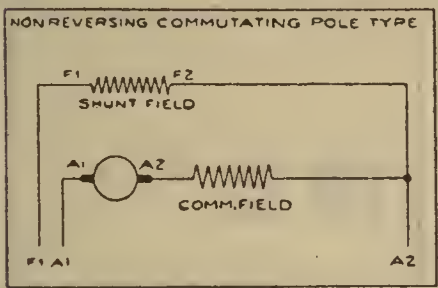
	D.C.	A.C.
Line	L_1, L_2,	L_1, L_2, L_3, Etc.
Brush on Commutator	A_1, A_2,	A_1, A_2, A_3, Etc.
Stator		T_1, T_2, T_3, Etc.
Series Field	S_1, S_2,	
Brush on Slip Ring (Rotor)		M_1, M_2, M_3, Etc.
Shunt Field	F_1, F_2,	F_1, F_2,
Commutating Field	C_1, C_2,	
Braking	B_1, B_2, B_3, Etc.	B_1, B_2, B_3, Etc.
Armature Resistance	R_1, R_2, R_3, Etc.	R_1, R_2, R_3, Etc.
Shunt Field Resistance	V_1, V_2, V_3, Etc.	
Transformer, High Voltage		H_1, H_2, H_3, Etc.
Transformer, Low Voltage		X_1, X_2, X_3, Etc.
Neutral Connection	Terminal letter with suffix 0.	

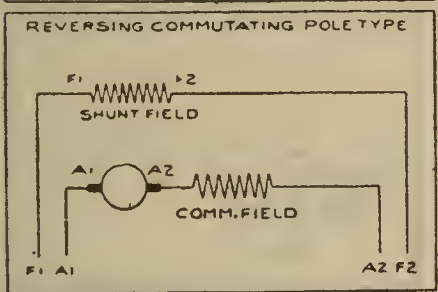
(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

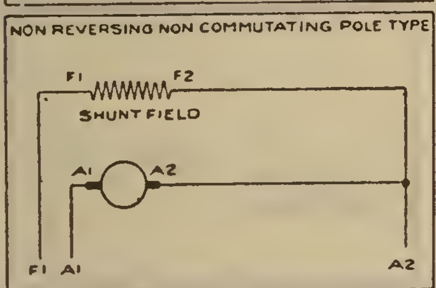
Reference
Number

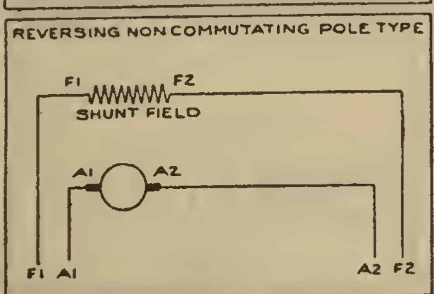
(5404-2) Terminal Markings of D. C. Motors, Shunt Wound.

Rotation, Non Reversing Motors, Counter-clockwise Facing End Opposite Drive.
On Non Reversible Motor Starters Shunt Field Terminal Should Be Marked
With The Word Field Machine Diagrams Will Not Show Control Connections
Aways Start With A Free Lead Marked Sub.1
All Internal Connections Go From Sub.2 TO Sub1







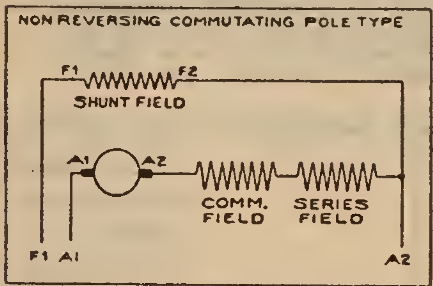


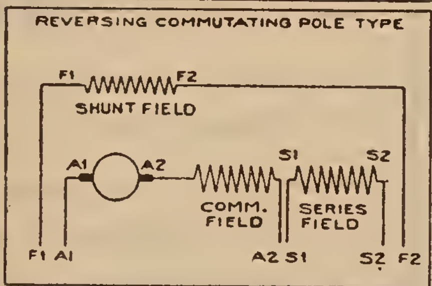
(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

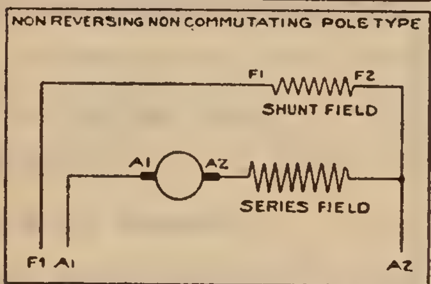
Reference
Number

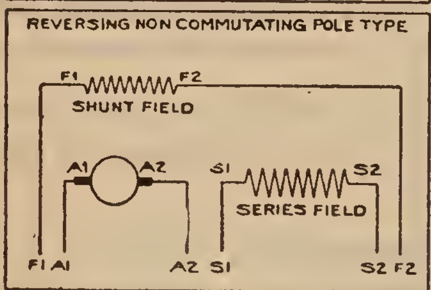
(5404-21) Terminal Markings of D. C. Motors, Compound Wound.

Rotation, Non Reversing Motors, Counter-clockwise Facing End Opposite Drive
On Non-reversible Motor Starters Shunt Field Terminal Should Be Marked
With The Word Field. Machine Diagrams Will Not Show Control Connections
Always Start With A Free Lead Marked Sub.1
All Internal Connections Go From Sub. 2 To Sub.1







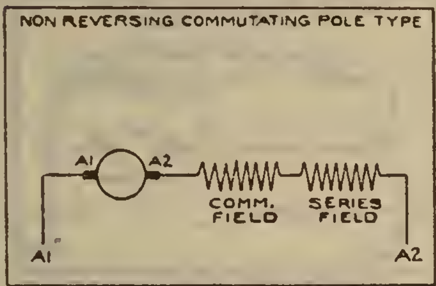


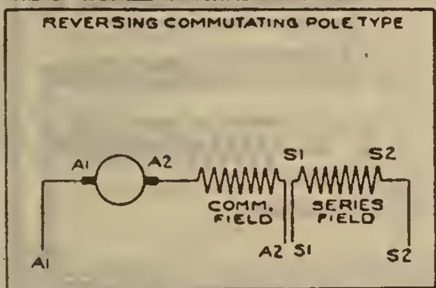
(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

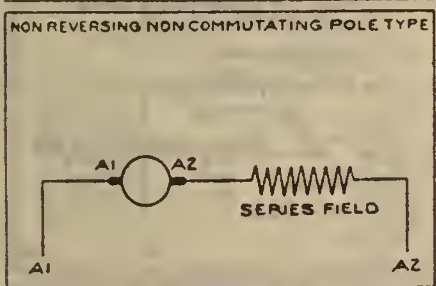
Reference
Number

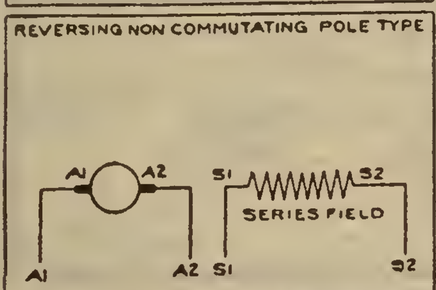
(5404-22) Terminal Markings of D. C. Motors, Series Wound.

Rotation, Non Reversing Motors, Counter-clockwise Facing End Opposite Drive
Machine Diagrams Will Not Show Control Connections
Always Start With A Free Lead Marked Sub.1
All Internal Connections Go From Sub.2 To Sub.1







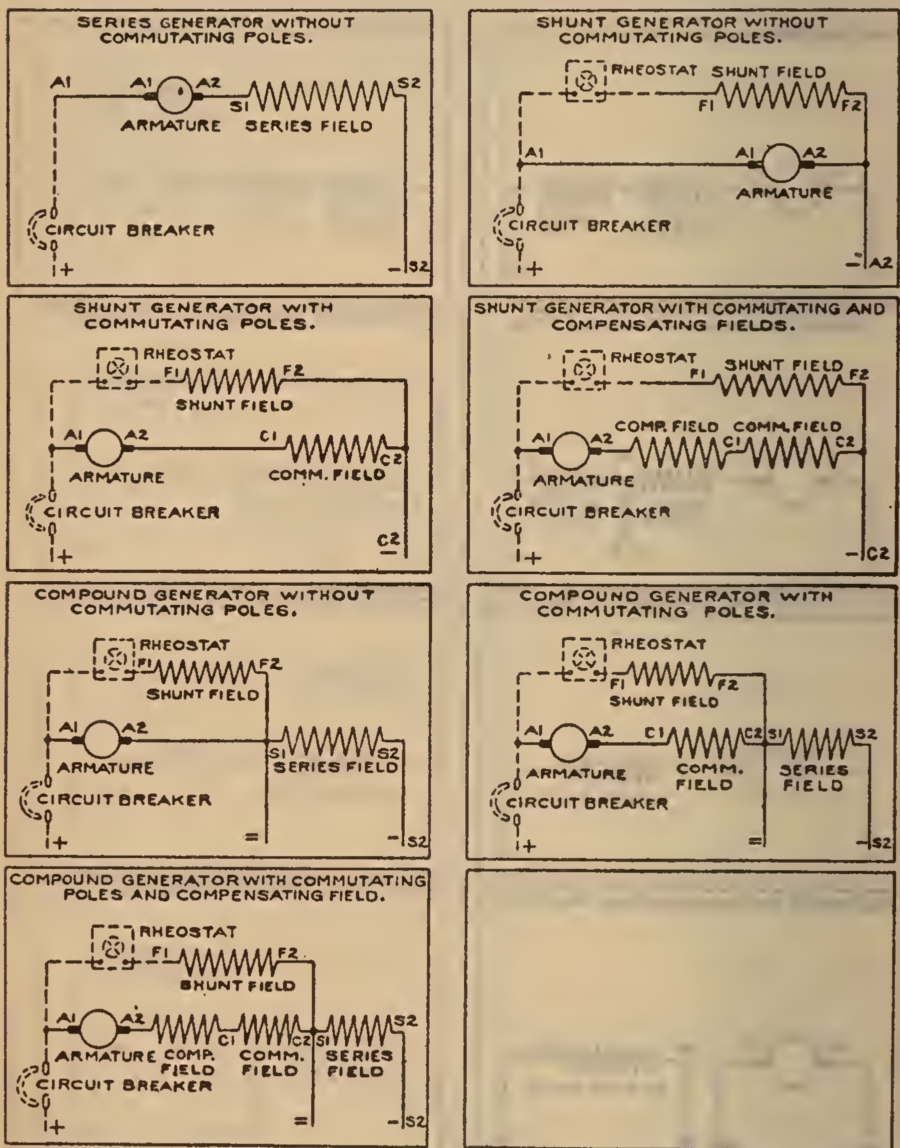


(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

Reference
Number

(5404-3) Terminal Markings of D. C. Generators, Two Wire.

Direction of Rotation Clockwise Facing End Opposite Drive.

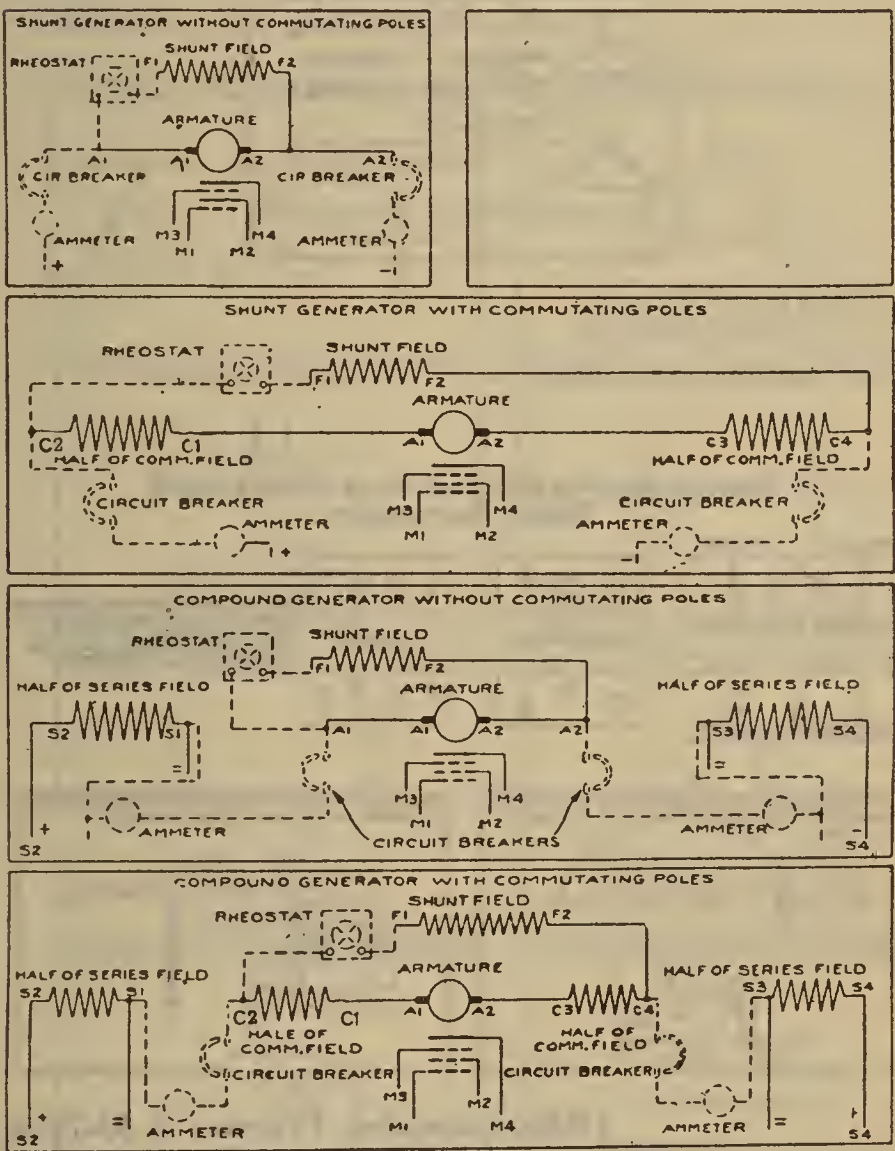


(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

Reference
Number

(5404-31) Terminal Markings of D. C. Generators, Three Wire.

Direction of Rotation Clockwise Facing End Opposite Drive.

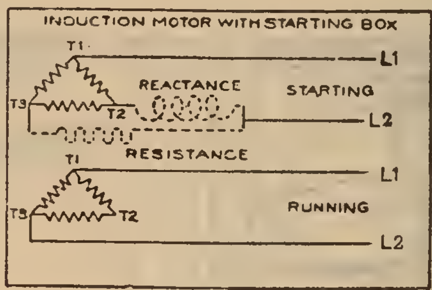


(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

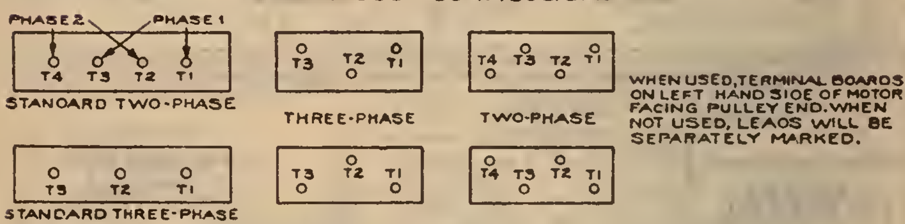
Reference
Number

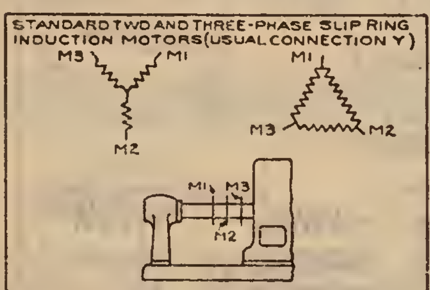
(5404-4) Terminal Markings of Induction Motors.

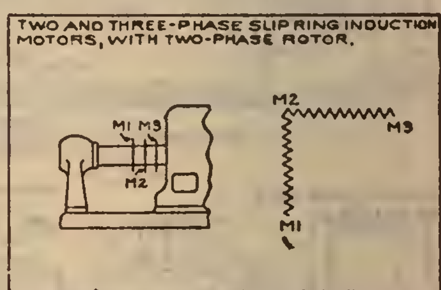
Induction Motor, Single-phase.



Induction Motors, Two and Three-phase
Rotor Connection.





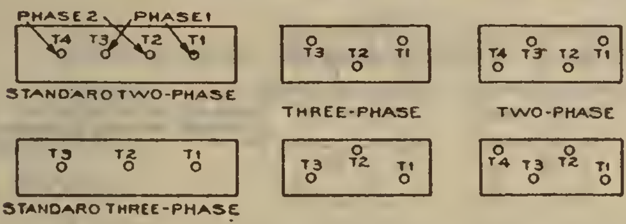


(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

Reference
Number

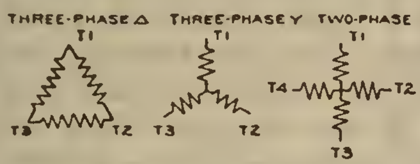
(5404-4 *Continued*)

Induction Motors, Two and Three-phase
Stator Connections.

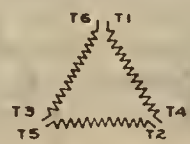


WHEN USED, TERMINAL BOARDS ON LEFT HAND SIDE OF MOTOR FACING PULLEY END. WHEN NOT USED, LEADS WILL BE SEPARATELY MARKED.

SINGLE SPEED, TWO AND THREE-PHASE

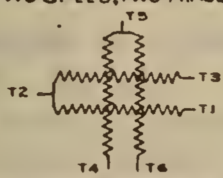


STARTING Y AND RUNNING Δ



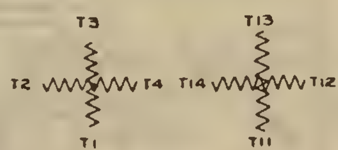
		L1	L2	L3	TOGETHER
STARTING	Y	T1	T2	T3	T4-T5-T6
RUNNING	Δ	T1-T6	T2-T4	T3-T5	

TWO SPEED, TWO-PHASE



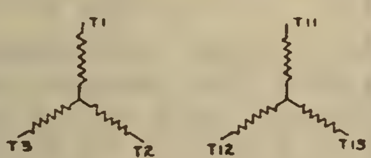
SPEED	L1	L3	L2	L4
LOW	T4	T6	T1	T3
HIGH	T5	T4-T6	T2	T1-T3

INDEPENDENT WINDING TWO SPEED TWO PHASE



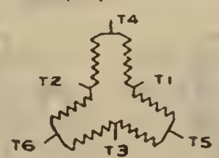
SPEED	L1	L2	L3	L4
LOW	T1	T2	T3	T4
HIGH	T11	T12	T13	T14

CONSTANT TORQUE, TWO SPEED, THREE-PHASE



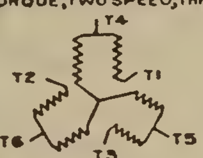
SPEED	L1	L2	L3
HIGH	T1	T2	T3
LOW	T11	T12	T13

CONSTANT TORQUE, TWO SPEED, THREE-PHASE



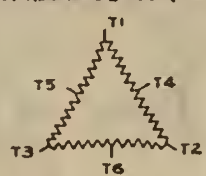
SPEED	L1	L2	L3	
LOW	T1	T2	T3	T4-T5-T6 OPEN
HIGH	T4	T5	T6	T1-T2-T3 TOGETHER

VARIABLE TORQUE, TWO SPEED, THREE-PHASE



SPEED	L1	L2	L3	
LOW	T1	T2	T3	T4-T5-T6 OPEN
HIGH	T4	T5	T6	T1-T2-T3 TOGETHER

CONSTANT H.P. TWO SPEED, THREE-PHASE



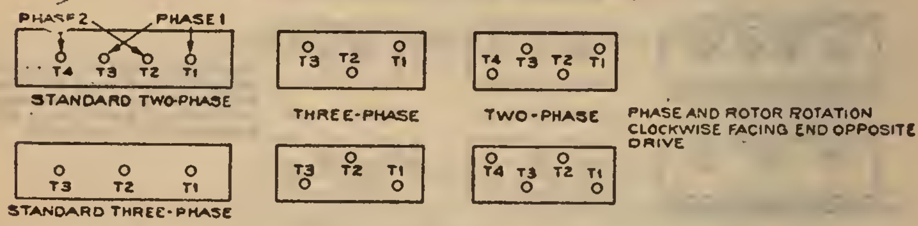
SPEED	L1	L2	L3	
LOW	T4	T5	T6	T1-T2-T3 TOGETHER
HIGH	T1	T2	T3	T4-T5-T6 OPEN

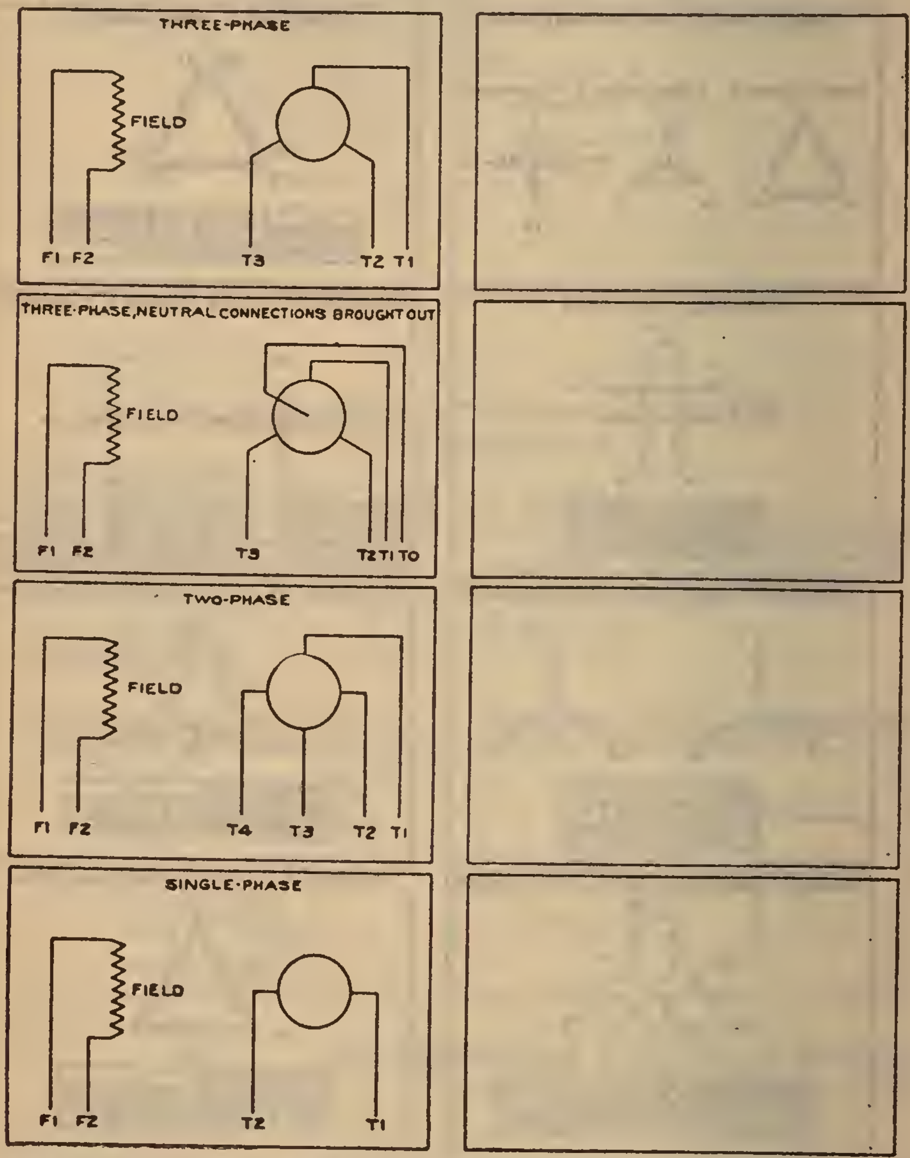
(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

Reference
Number

(5404-5) Terminal Markings of A. C. Generators and Synchronous Motors.

Single-phase, Two-phase and Three-phase.





(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

Reference
Number
(5406)

Constant Potential Transformers

STANDARD LEAD MARKINGS

*Rules for Transformer Lead Markings

(These rules do not apply to Auto Transformers.)

GENERAL

1. Scope.

These rules specify the markings of leads brought out of the case but not the markings of winding terminals inside of the case, except that these terminals shall be marked with numbers in any manner that will permit of convenient reference and that cannot be confused with the markings of the leads brought out of the case.

NOTE.—It is recognized that special cases will arise from time to time that these rules will not cover and that it would be very difficult to cover by any set of general rules.

2. Markings of Leads.

(a) In General. The leads shall be distinguished from one another by marking each lead with a capital letter followed by a number. The letters to be used are H for high voltage leads, X for low voltage leads and Y for tertiary winding leads. The numbers to be used as 1, 2, 3, etc.

NOTE.—By "tertiary winding" is meant a third winding that, compared with both of the other two windings, has smaller Kv-a rating than either or, if the Kv-a rating is the same as one or both of the other two, has lower voltage.

E.g., if a transformer has three separate windings, one for 1000 Kv-a, 33000 volts, one for 600 Kv-a, 550 volts and one for 400 Kv-a 6600 volts, the 400 Kv-a winding is the tertiary winding.

Or, if a transformer has three separate windings each with a capacity of 1000 Kv-a, and with voltages of 33000, 6600 and 550 respectively, the 550 volt winding is the tertiary winding.

According to this definition neither one of two similar windings arranged for series-parallel connection is to be classed as a tertiary winding.

*In accordance with the recommendations of the General Conference Committee on Technical Subjects—February, 1918, with subsequent modifications. The Conference Committee represented the following associations: American Institute of Electrical Engineers, National Electric Light Association, The Electric Power Club and the Association of Edison Illuminating Companies.

Reference Number

(5406 *Continued*) Recommended Practice Revised 5-30-1918.)

(b) A neutral Lead shall be marked with the proper letter followed by O, e.g., HO, XO.

Exception.—A lead brought out from the middle of a winding for some other use than that of neutral lead, e.g., a 50% starting tap, shall be marked as a tap lead.

3. **Diagrammatic Sketch of Connections.**

The manufacturer shall furnish with each transformer a complete diagrammatic sketch showing the leads and internal connections and their markings and the voltages obtainable with the various connections.

This sketch should preferably be on a metal plate attached to the transformer case.

SINGLE PHASE TRANSFORMERS.

4. **Order of Numbering Leads in any Winding.**

The leads of any winding (high voltage, low voltage or tertiary) brought out of case shall be numbered 1, 2, 3, 4, 5, etc., the lowest and highest numbers marking the full winding and the intermediate numbers marking fractions of winding or taps. All numbers shall be so applied that the potential difference from any lead having a lower number toward any lead having a higher number shall have the same sign at any instant.

If a winding is divided into two or more parts for series parallel connections, and the leads of these parts are brought out of case, the above rule shall apply for the series connection with the addition that the leads of each portion of winding shall be given consecutive numbers. (Figs. 5 and 6, page 95.)

5. **Relation of Order of Numbering Leads of Different Windings.**

The numbering of the high voltage and low voltage leads shall be so applied that when H1 and X1 are connected together and voltage applied to the transformer, the voltage between the highest numbered H lead and the highest numbered X lead shall be less than the voltage of the full high voltage winding.

The same relation shall apply between high voltage and tertiary and low voltage and tertiary winding.

Reference
Number

(5406 *Continued*) (Recommended Practice 5-30-1918.)

6. Polarity.

When leads are marked in accordance with the above rules, the polarity of a transformer is

Subtractive when H1 and X1 are adjacent (Figs. 1, 3 and 5).

Additive when H1 is diagonally located with respect to X1 (Figs. 2, 4 and 6, page 95).

7. Location of H1 Lead.

To simplify the work of connecting transformers in parallel it is recommended that the H1 lead shall be brought out on the right hand side of the case, facing high voltage side of the case.

8. Parallel Operation.

Transformers having leads marked in accordance with these rules may be operated in parallel by connecting similarly marked leads together, provided their ratios, voltages, resistances and reactances are such as to permit parallel operation.

In some cases design may be such as to permit parallel operation, although due to the difference in the number of tap leads, the leads to be connected together may not have the same number.

THREE PHASE TRANSFORMERS.

9. Marking of Full Winding Leads.

The (3) high voltage leads and the (3) low voltage leads which connect to the full phase windings, shall be marked H1, H2, H3 and X1, X2, X3. The full phase winding of a tertiary winding shall be marked Y1, Y2, Y3.

10. Relation between High and Low Voltage Windings.

(a) The markings shall be so applied that if the phase sequence of voltage on the high voltage side is in the time order H1, H2, H3 it is in the time order of X1, X2, X3 on the low voltage side and Y1, Y2, Y3 for a tertiary winding.

(b) Angular Displacement.

In order that the markings of lead connections between phases shall indicate definite phase relations, they shall be made in accordance with one of the three-phase groups shown in Figs. 7 to 14, inc., page 96. The angular displacement between the high voltage and low

Reference
Number

(5406 *Continued*) (Recommended Practice 5-30-1918.)
voltage windings is the angle in each of the voltage vector diagrams (Figs. 7-14, inc., page 96), between the lines passing from its neutral point through H1 and X1, respectively.

Any three phase transformer having a delta Y connection may be represented by voltage vector diagram either in accordance with Figure 11 or Figure 13. Any three phase transformer having Y delta connection may be represented by voltage vector diagram either in accordance with Fig. 12 or 14, page 96. Since these voltage vector diagrams are equivalent, it is recommended that the terminal markings for three phase transformers having delta Y connection be always made in accordance with Figure 11 and that the terminal markings for three phase transformers having Y delta connection be always made in accordance with Figure 12, page 96.

11. Tap Leads.

(a) Where tap leads are brought out of the case (neutral lead excepted) they shall be marked with the proper letter followed by the figures 4, 7, etc., for one phase, 5, 8, etc., for another phase, and 6, 9, etc., for the third phase. (See Fig. 15, page 96.

(b) Delta Connection. The order of numbering tap leads shall be as follows: 4, 7, etc., from lead 1 toward lead 2; 5, 8, etc., from lead 2 toward lead 3; and 6, 9, etc., from lead 3 toward lead 1. (See Fig. 15, page 96.)

(c) Star Connection. The order of numbering tap leads shall be as follows: 4, 7, etc., from lead 1 towards neutral; 5, 8, etc., from lead 2 towards neutral; and 6, 9, etc., from lead 3 towards neutral. (See Fig. 15, page 96.)

12. Interphase Connection Made Outside of Case.
Where the interphase connections are made outside of case, the leads will be marked with the proper letter followed by the numbers 1, 4, 7, 10, etc., for one phase; 2, 5, 8, 11, etc., for the second phase; and 3, 6, 9, 12, etc., for the third phase.

The markings shall be so applied that when a star connection is made by joining together the highest numbered leads of each phase, all rules here given, excepting rule (2b) apply.

Reference
Number
(5406 *Continued*) (Recommended Practice 5-30-1918.)

13. Parallel Operation.

Transformers having leads marked in accordance with these rules may be operated in parallel by connecting similarly marked leads together provided their angular displacements are the same and provided also their ratios, voltages, resistances, and reactances are such as to permit parallel operation.

NOTE.—In some cases designs may be such as to permit parallel operation although, due to a difference in the number of tap leads, the leads to be connected together are not similarly marked.

14. Location of H1 Lead.

To simplify the work of connecting transformers in parallel it is recommended that the H1 lead shall be brought out on the right hand side of the case, facing the high voltage side of the case.

THREE PHASE TO SIX PHASE TRANSFORMERS.

15. Rules for Three Phase Transformers that are Applicable.

Rules 10b and 12 shall apply to three phase to six phase transformers. Rules 9 and 11 shall apply to three phase windings, but not to six phase windings.

16. Markings of Six Phase Leads.

The six leads which connect to the full phase windings shall be marked X1, X2, X3, X4, X5, X6. (Figs. 16-19, incl., page 97.)

17. Relation Between Three Phase and Six Phase Windings.

(a) The markings shall be so applied that if the phase sequence of voltage on the three phase side is in the time order H1, H2, H3, it is in the time order of X1, X2, X3, X4, X5, X6 on the six phase side.

(b) Angular Displacement.

In order that the markings of lead connections between phases shall indicate definite phase relations, they shall be made in accordance with one of the four, six phase groups shown in Figs. 16 to 19, inclusive. The angular displacement between the high voltage and low voltage windings is the angle in each of the voltage vector diagrams from its neutral through H1 and X1 respectively.

Reference
Number
(5406 *Continued*)

18. Tap Leads.

Where tap leads from low voltage windings are brought out of the case (neutral lead excepted), they shall be marked as follows:

(a) Diametrical Connection tap leads shall be marked from the two ends of each phase winding towards the middle or neutral point in the following order: X7, X13, etc., from X1 towards neutral; X8, X14, etc., from X2 towards neutral; X9, X15, etc., from X3 towards neutral; X10, X16, etc., from X4 towards neutral; X11, X17, etc., from X5 towards neutral; X12, X18, etc., from X6 towards neutral. (See Fig. 20, page 97.)

A tap from the middle point of any phase winding, not intended as a neutral, shall be given a number determined by counting from X1, X2 or X3 and not from X4, X5, or X6; e.g., if the only taps brought out are 50% starting taps, they shall be numbered X7, X8 and X9.

(b) Double Delta Connection. Tap leads shall be marked in the following order: X7, X13, etc., from X1 towards X3; X8, X14, etc., from X2 towards X4; X9, X15, etc., from X3 towards X5; X10, X16, etc., from X4 towards X6; X11, X17, etc., from X5 towards X1; X12, X18, etc., from X6 towards X2. (See Fig. 21, page 97.)

NOTE.—For starting purposes it is generally customary to bring out only two taps from one delta and start three-phase.

(Recommended Practice 5-30-1918.)

Reference
Number

(5406 *Continued*)

Lead Markings for Single Phase Transformers.

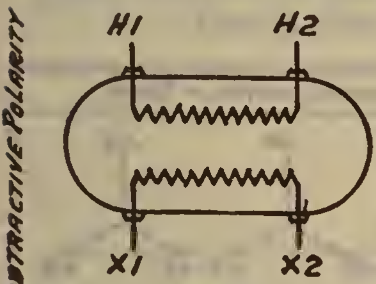


FIG. 1

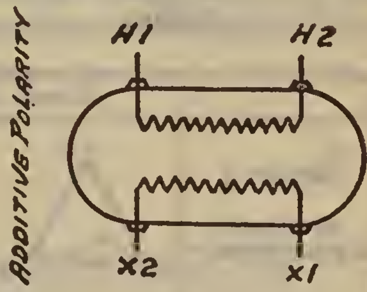


FIG. 2

SIMPLE HIGH AND LOW VOLTAGE WINDINGS
WITHOUT TAPS

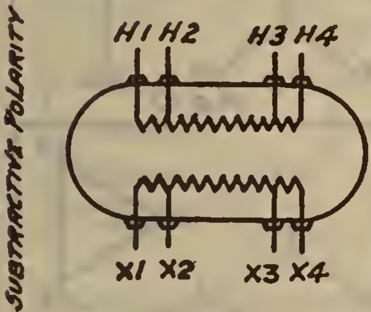


FIG. 3

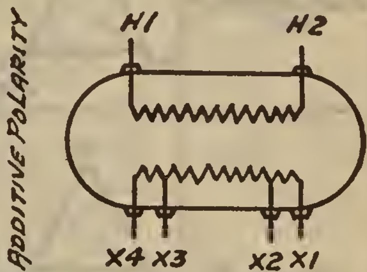
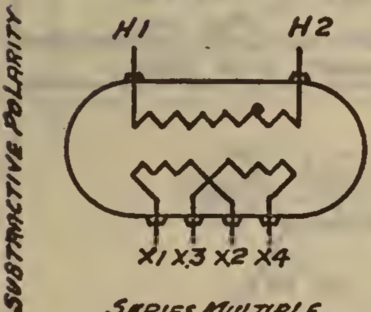


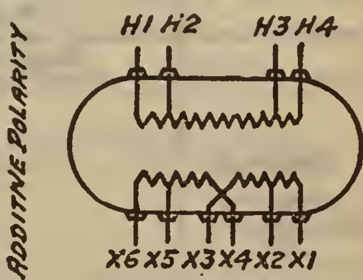
FIG. 4

SIMPLE HIGH AND LOW VOLTAGE WINDINGS
WITH TAPS



SERIES MULTIPLE
LOW VOLTAGE WINDING
WITHOUT TAPS

FIG. 5



SERIES MULTIPLE
LOW VOLTAGE WINDING
WITH TAPS

FIG. 6

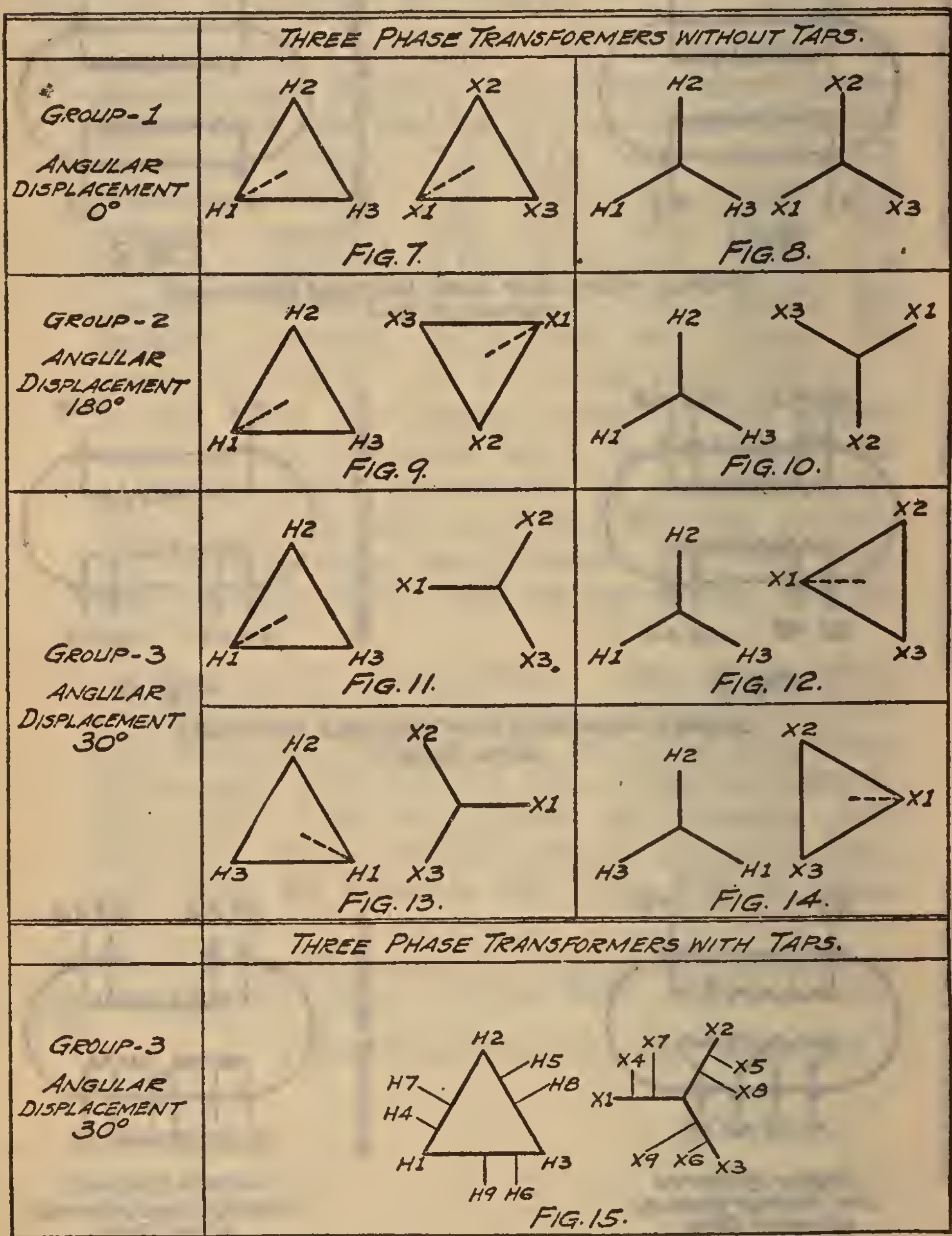
NOTE:—The above figures illustrate the application of the rules on lead markings to transformers having subtractive and additive polarity.

(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

Reference
Number

(5406 *Continued*)

Lead Markings and Voltage Vector Diagrams for the Usual Three Phase Transformer Connections.

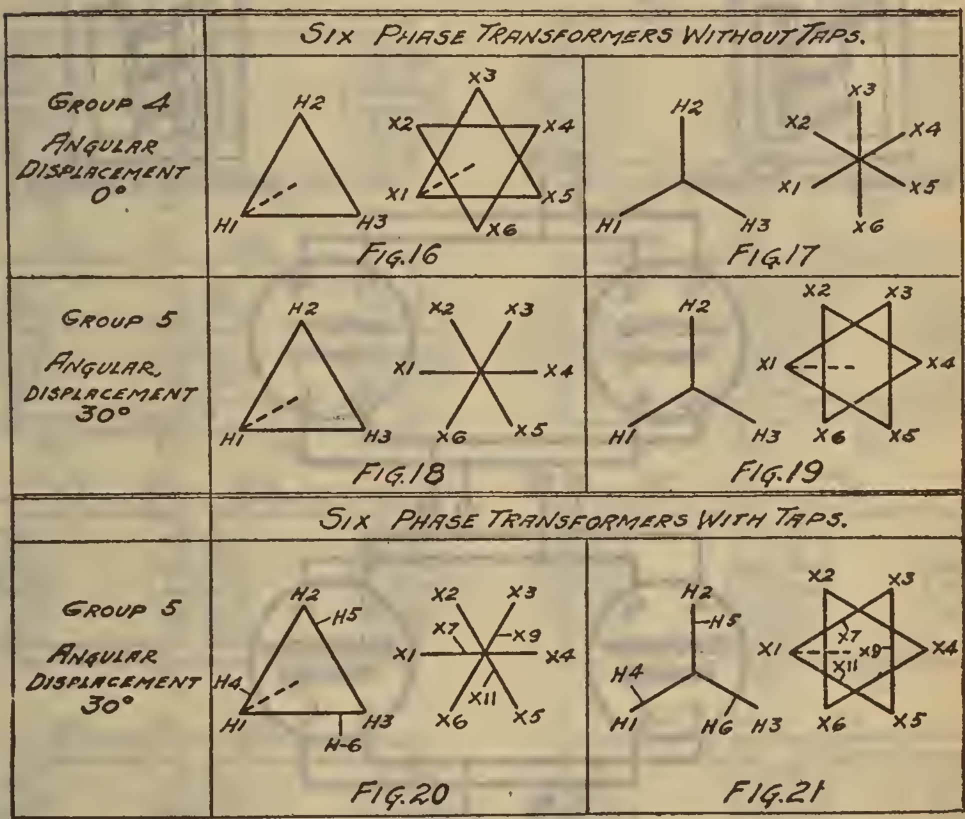


NOTE:—The above figures are included to illustrated the method of marking transformer leads that are brought out of the case and are not intended to standardize connections, vector diagrams or polarity.

(Recommended Practice 5-30-1918.)
(Adopted Standard 6-1-1919.)

Reference
Number
(5406 *Continued*)

Lead Markings and Voltage Vector Diagrams for the Usual Six Phase Transformer Connections.

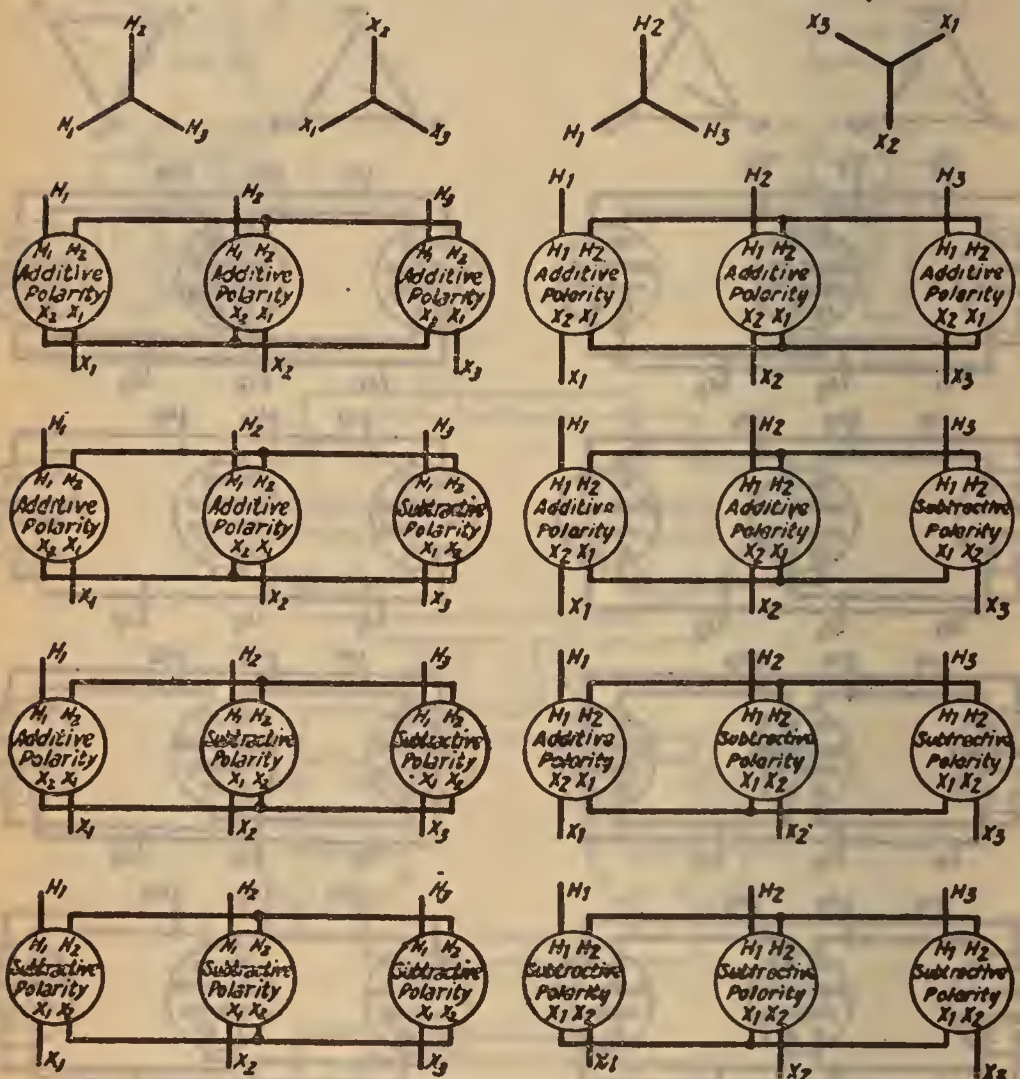


NOTE:—The above figures are included to illustrate the method of marking transformer leads that are brought out of the case and are not intended to standardize connections, vector diagrams or polarity.

(Recommended Practice 5-30-1919.)
(Adopted Standard 6-1-1919.)

Reference
Number
(5406 *Continued*)

Angular Displacement and Connections for Single Phase Transformers in Three Phase Banks.



Angular Displacement
0 degrees

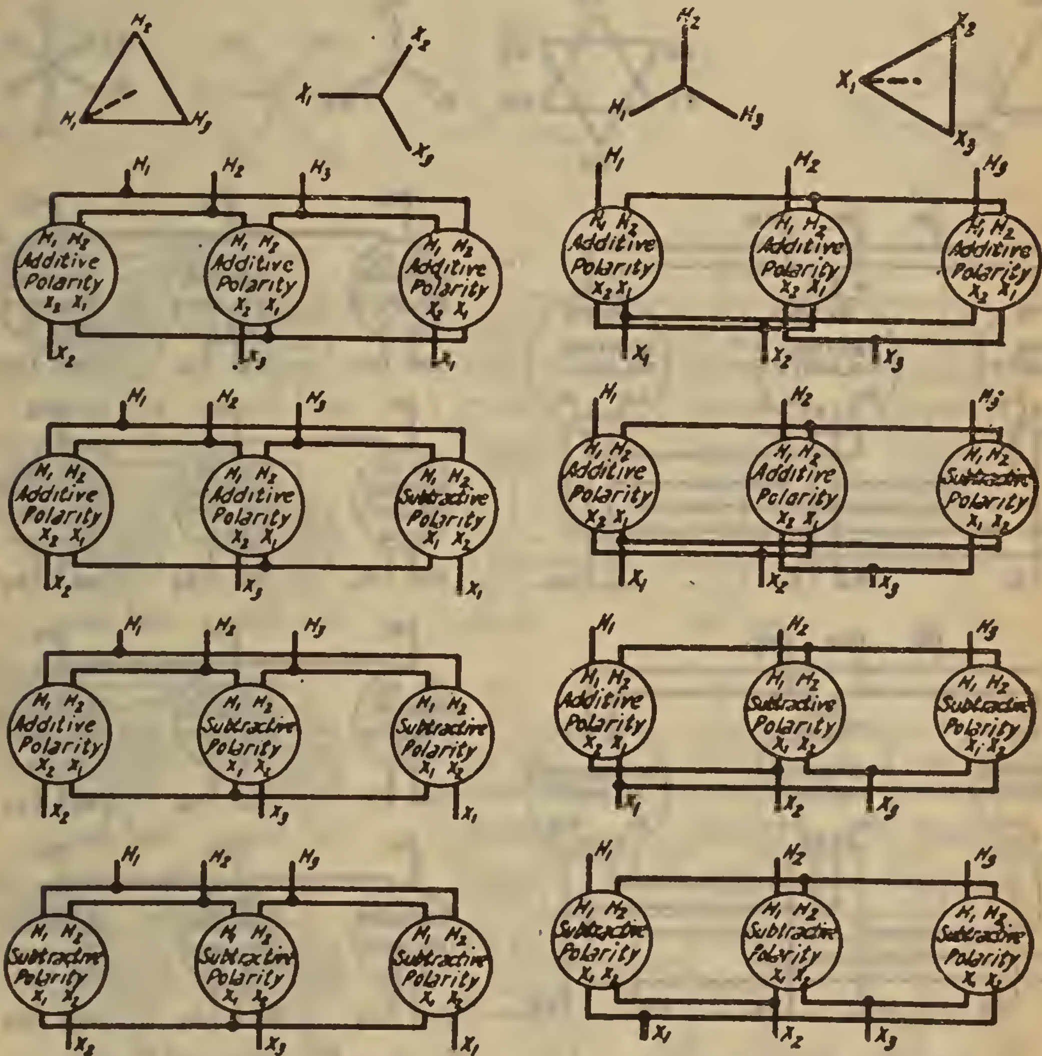
Angular Displacement
180 degrees

Fig. III.

NOTE.—The above figures are included as matter of information to illustrate connections of single phase transformers of Additive Polarity, Subtractive Polarity, and Additive and Subtractive Polarity in banks for the various recognized angular displacements. (6-7-1921.)

Reference
Number
(5406 *Continued*)

Angular Displacement and Connections for Single Phase Transformers in Three Phase Banks.



Angular Displacement
30 degrees

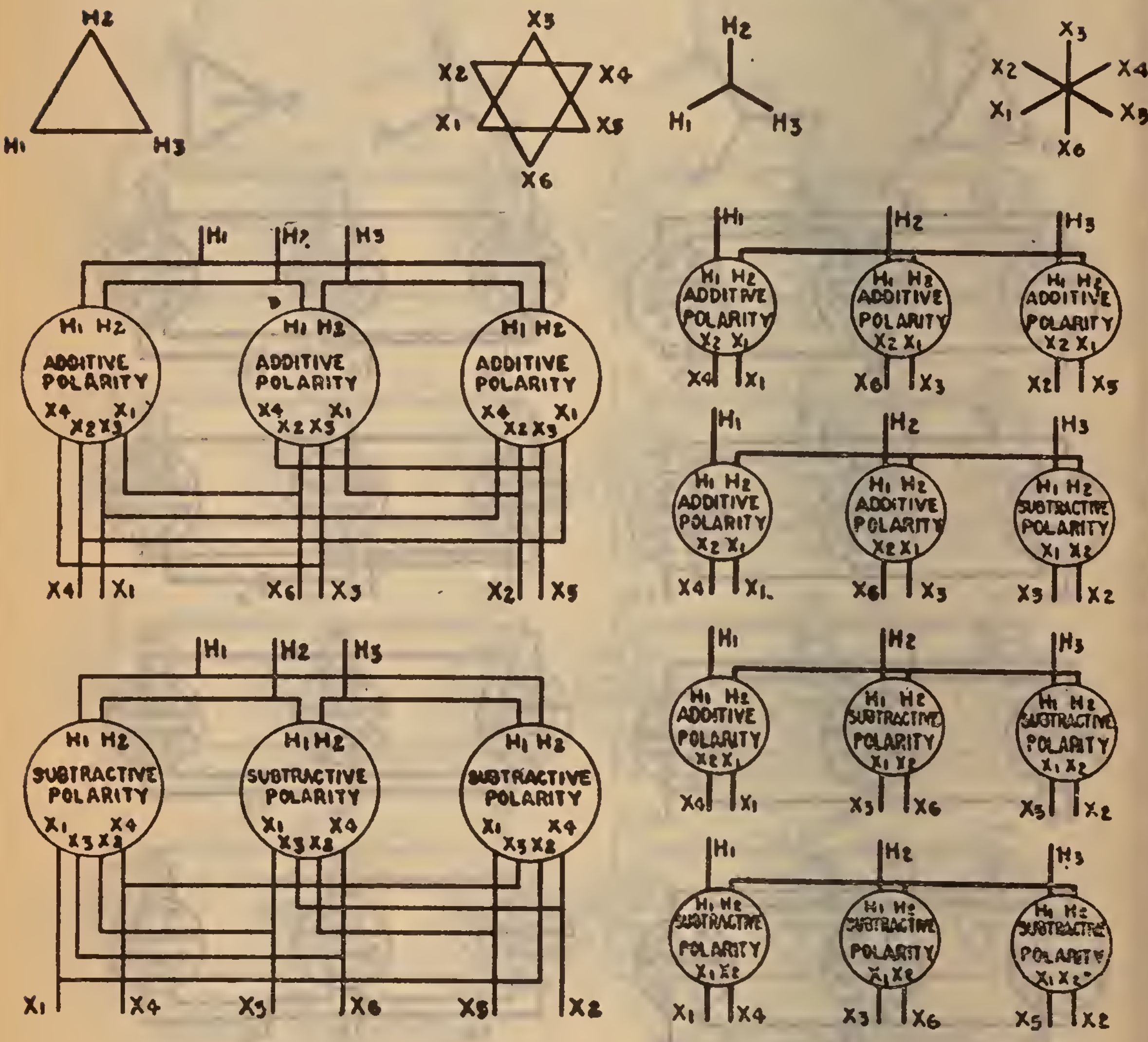
Angular Displacement
30 degrees

Fig. IV.

NOTE.—The above figures are included as matter of information to illustrate connections of single phase transformers of Additive Polarity, Subtractive Polarity, and Additive and Subtractive Polarity in banks for the various recognized angular displacements. (6-7-1921.)

Reference
Number
(5406 *Continued*)

Angular Displacement and Connections for Single Phase Transformers When Transforming Three to Six Phase.



Angular Displacement
0 degrees

Angular Displacement
0 degrees

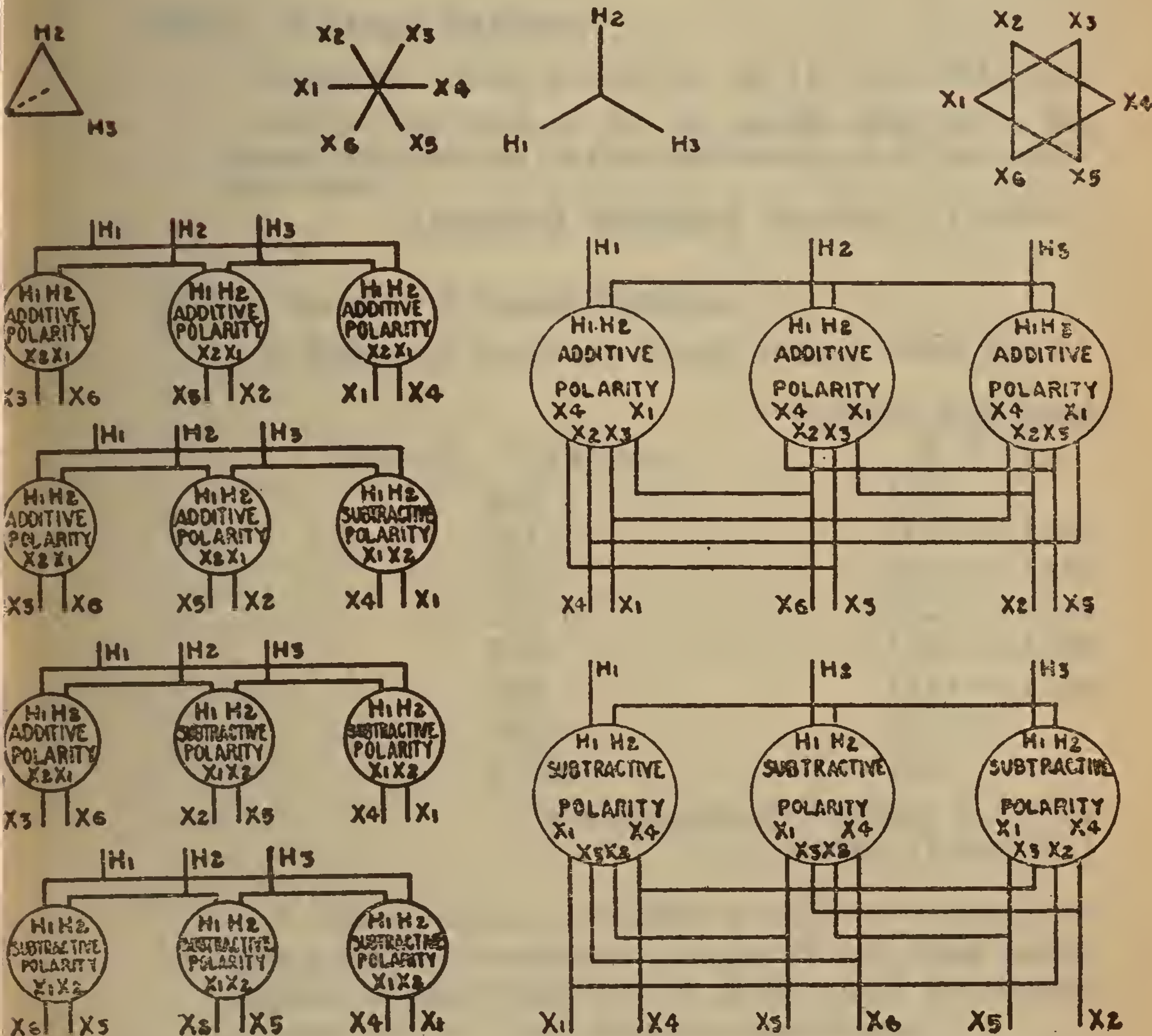
Fig. V.

NOTE.—The above figures are included as matter of information to illustrate connections of single phase transformers of Additive Polarity, Subtractive Polarity, and Additive and Subtractive Polarity in banks for the various recognized angular displacements. (6-7-1921.)

Reference
Number

(5406 *Continued*)

Angular Displacement and Connections for Single Phase Transformers When Transforming Three to Six Phase.



Angular Displacement
30 degrees

Angular Displacement
30 degrees

Fig. VI.

NOTE.—The above figures are included as matter of information to illustrate connections of single phase transformers of Additive Polarity, Subtractive Polarity, and Additive and Subtractive Polarity in banks for the various recognized angular displacements. (6-7-1921.)

March, 1922

FRACTIONAL HORSE POWER MOTORS — DIRECT CURRENT

(Motors of less than 1 H. P.—see definition Reference Number 1110)

Reference Number

(6115) RATING STANDARDS.

(6117) Voltage Ratings.

Standard voltages shall be 32, 115 and 230 volts.

NOTE—The fields of 32 volt motors shall be so designed that they can be run continuously on 40 volts without injury.

(Adopted Standard Revised 1-15-1919.)

(6119) Load and Speed Ratings.

1. Standard load and speed ratings shall be:

Brake H. P. Ratings	Approx. Full Load R. P. M.
3/4	1725
1/2	1725 — 1140
1/3	1725 — 1140
1/4	1725 — 1140
1/6	1725 — 1140
1/8	1725 — 1140
1/12	1725
1/20	1725

(Recommended Practice 5-3-1916, Amended 11-17-1920.)

2. When motors operating at other than the foregoing standard speeds are required, full load speeds approximating those of 25 or 60 cycle alternating current motors shall be given preference.

(Recommended Practice 5-22-1911.)

(6120) STANDARD WINDINGS.

The standard windings for ½ and ¾ H.P. motors shall be both shunt and compound; for ¼, 1/6 and ⅛ H.P. motors, compound; for 1/12 and 1/20 H.P. shunt.

(Adopted Standard 1-15-1919.)

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1/3	1725 — 1140
1/4	1725 — 1140
1/6	1725 — 1140
1/8	1725 — 1140
1/12	1725
1/20	1725

(Recommended Practice 5-3-1916, Amended 11-17-1920.)

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(Adopted Standard 1-15-1919.)

Reference Number

(6130) PERFORMANCE SPECIFICATONS.

(6131) Temperature Rise.

Temperature Rise in degrees centigrade of all parts when operating under normal rated conditions as specified on the nameplate.

Class of insulation	A
Load, per cent of rated capacity	100
Time rating	Continuous
Open type	40°
Enclosed type	55°

(Adopted Standard Maximum Limit 10-30-1911.)

No overload temperature guarantee given.

For descriptive specification covering Class A insulation see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings, see Reference Number 5303.

A 50 degree open type continuous duty motor for general purposes as distinguished from a 50 degree special application motor described in the above rules is a "Recognized Departure" from the standards of The Electric Power Club. See Reference Number 20,000.

(Recommended Practice 5-3-1916.)

(6139) Change in Speed Due to Heating.

Variation in speed from full load cold to full load hot during run of specified period shall not exceed 10 per cent, based on the full load speed hot.

(Adopted Standard Maximum Limit 5-3-1916.)

(6140) Dielectric Test.

1. Dielectric test for motors in capacities of ½ H. P. output (or 373 watts output) and larger shall be made by applying twice the normal voltage of the circuit to which the appratus is connected, plus 1,000 volts.

(Adopted Standard Minimum Limit 11-15-1916.)

2. Dielectric test for motors in capacities of less than ½ H. P. output (or 373 watts output), for operation upon circuits not exceeding 250 volts, shall be made by applying 900 volts. Motors above 250 volts shall be tested in accordance with first paragraph.

(Adopted Standard Minimum Limit 11-15-1916.)

Reference Number

(6140 *Continued*)

3. The specified A.C. test voltage shall be applied for one minute immediately after conclusion of the manufacturer's shop tests. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. All windings, except that under test, shall be connected to ground. The frequency of the testing circuit shall be 60 cycles, and the crest value of the total voltage shall be the square root of two, times the specified test voltage.

(Adopted Standard 5-30-1918.)

Equivalent Shop Test

For all motors manufactured in large quantities an A. C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

(6143) Allowable Variation from Rated Voltage.

Motors shall operate successfully with normal rated current at any voltage not more than 10 per cent above or below normal, but not necessarily in accordance with the standards of performance established for operation at normal rating.

(Adopted Standard 5-3-1916.)

(6144) Allowable Variation from Rated Speed.

At normal operating temperature and voltage, a variation of seven and one-half per cent (7½%) above or below any rated speed is permissible.

(Adopted Standard Maximum Limit Revised 5-3-1916.)

(6149) General Guarantee.

See Reference Numbers 2001 to 2004 incl.

(6170) STANDARD MANUFACTURING PRACTICE.

(6171) Pulley Dimensions.

Standard Pulley Dimensions shall be:

FLAT-FACED PULLEYS.

Dia.	Face	Bore.	Key.
3½″	2½″	¾″	3/16″ square
3 ″	2¼″	¾″	3/16″ square
2½″	1¾″	⅝″	3/16″ square

Reference Number
(6171 *Continued*)

GROOVED PULLEYS.

Pitch Diam.	Belt Diam.	Bore	Set Screw.
2 "	5/16"	1/2"	5/16"—24 thread
1 5/8"	5/16"	1/2"	5/16"—24 thread
1 1/2"	1/4"	3/8"	5/16"—24 thread

NOTE.—The 1 5/8x5/16" pulley, when used with a 1/4" belt, gives pulley dimensions of 1 1/2"x1/4". Groove pulley should be arranged for mounting upon the shaft provided with a flat and secured by a set screw.

(Adopted Standard 5-7-1920.)

(6172) Shaft Diameters.

Standard shaft diameters shall be as follows:

H. P.	Rated Speed	Shaft Extension Diameter
3/4	1725	3/4-inch
1/2	1725	3/4-inch
1/3	1725	5/8-inch
1/4	1725	5/8-inch
1/6	1725	1/2-inch
1/8	1725	1/2-inch
1/12	1725	1/2-inch
1/20	1725	3/8-inch

(Adopted Standard Revised 5-3-1916.)

(6173) Shaft Extensions.

The standard shaft extension for fractional horsepower motors shall be three times the shaft diameter.

(Recommended Practice 11-17-1920.)

(6174) Tolerance Limits in Dimensions.

For belted type motors only, the allowable variation in the distance between the base of the motor and the center of the shaft, measured at the end of the shaft, shall be within the limits of plus 0 and minus 1/16".

(Adopted Standard Maximum and Minimum Limits 5-3-1916.)

Reference
Number

(6175) Name Plate Marking.

The following minimum amount of information shall be given on all name plates:

(a) Manufacturers Type and Frame designation.
(b) Horse Power output.
(c) Time rating—See Reference Number 5300.
(d) Temperature rise.
(e) R.P.M. at full load.
(f) Voltage.
(g) Full Load amperes.
(h) Winding—Shunt, compound or series.

(Recommended Practice Revised 6-11-1917.)

(6178) Direction of Rotation.

See Reference Number 5401.

(6180) Terminals.

Terminals of Fractional Horsepower Motors shall consist of flexible single conductor leads brought out of the frame or bearing brackets of the motor through an insulated hole or holes, and any other form of connection shall be considered special and extra. Such terminals shall be approximately 9″ long for ¼ H.P. 1725 R. P. M. motors and smaller, and approximately 12″ long for sizes larger. (Adopted Standard 5-7-1920.)

(6181) Frame Designation.

The stationery element or the name plate of each motor shall be marked with the manufacturer's frame designation. (Recommended Practice 5-13-1915.)

(6190) STANDARD COMMERCIAL PRACTICE.

(6191) Resistance Starter.

A resistance starter shall be standard for use with shunt wound and compound wound motors in capacities of ½ H. P. and larger.

(Recommended Practice 5-3-1916.)

FRACTIONAL HORSE POWER MOTORS — ALTERNATING CURRENT

(Motors of less than 1 H. P.—see definition Reference Number 1110)

Reference
Number

(6201) Classification of Single Phase Motors.

1. Commutator Type:
   - (a) With commutator for starting only—constant speed.
   - (b) With commutator for starting and running—constant and varying speed.

(Adopted Standard 11-18-1916.)

2. Split Phase:
   - (a) With clutch—constant speed.
   - (b) Clutchless—constant speed.

(Adopted Standard 11-18-1916.)

(6215) RATING STANDARDS.

(6217) Voltage Ratings.

Standard voltages shall be 110 and 220 volts.

(Adopted Standard 6-8-1914.)

(6218) Frequencies.

Standard frequencies shall be 25 and 60 cycles per second. (Adopted Standard.)

(6219) Load and Speed Ratings.

Standard load and speed ratings shall be:

	60 Cycle Circuit		25 Cycle Circuit	
Brake H. P. Rating	Synchronous R. P. M.	Approximate Full Load R. P M.	Synchronous R. P. M.	Approximate Full Load R. P. M.
3/4	1800	1725		
1/2	1800—1200	1725—1140	1500	1425
1/3	1800—1200	1725—1140	1500	1425
1/4	1800—1200	1725—1140	1500	1425
1/6	1800—1200	1725—1140	1500	1425
1/8	1800—1200	1725—1140	1500	1425
1/12	1800	1725	1500	1425
1/20	1800	1725	1500	1425

(Recommended Practice 1-15-1919,
Amended 11-17-1920.)

Reference
Number

(6230) PERFORMANCE SPECIFICATIONS.

(6231) Temperature Rise.

Temperature Rise in degrees centigrade of all parts when operating under normal rated conditions as specified on the name plate.	
Class of insulation	A
Load, % of rated capacity	100
Time rating	Continuous
Open type Enclosed type	40° 55°

(Adopted Standard Maximum Limit 10-30-1911.)

No overload temperature guarantee given.

For descriptive specification covering Class A insulation see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply, and deterioration of insulation may be expected. if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see Reference Number 5303.

A 50 degree open type continuous duty motor for general purposes as distinguished from a 50 degree special application motor described in the above rules is a "Recognized Departure" from the standards of The Electric Power Club. See Reference Number 20,000.

(6237) Torque Characteristics.

Torque characteristics expressed as multiple of full load torque for 25 cycle and 60 cycle fractional horsepower motors:

Type of Motor:	*Pull-out Torque*	*Starting Torque*	*Pull-in Torque*
Split phase clutch motors..	2	1¾ to 2	
Split phase clutchless motors	2	1 to 1½	
Repulsion induction motors	2	2 to 4	1¼ to 1¾
Polyphase motors	2	1½ to 1¾	

(Recommended Practice—Minimum Limit 11-9-1915,
Amended Recommended Practice—
Minimum Limit 11-17-1920.)

Reference
Number

(6240) Dielectric Test.

1. Dielectric test for motors of ½ H. P. output (or 373 watts output) and larger, shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1,000 volts.

(Adopted Standard Minimum Limit 11-18-1916.)

2. Dielectric test for motors in capacities of less than ½ H. P. output (or 373 watts output), for operation upon circuits not exceeding 250 volts, shall be made by applying 900 volts. Motors above 250 volts shall be tested in accordance with first paragraph.

(Adopted Standard Minimum Limit 11-18-1916.)

3. The specified A.C. test voltage shall be applied for one minute immediately after conclusion of manufacturer's shop test. The test voltages shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. Inter-connected circuits are considered as one circuit. All windings except that under test should be connected to the ground. The frequency of the testing circuit shall be 60 cycles, and the crest value of the test voltage shall be the square root of two times the specified voltage.

(Adopted Standard 5-30-1918.)

Equivalent Shop Test

For all motors manufactured in large quantities an A.C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

(6243) Allowable Variation from Rated Voltage.

Motors shall operate successfully with normal rated current and frequency at any voltage not more than 10% above or below normal, but not necessarily in accordance with the standards of performance established for operation at normal rating.

(Adopted Standard 5-3-1916.)

(6249) General Guarantee

See Reference Numbers 2001 to 2004 incl.

Reference
Number

(6270) STANDARD MANUFATURING PRACTICE.

(6271) Pulley Dimensions.

Standard Pulley Dimensions shall be:

FLAT-FACED PULLEYS.

Dia.	Face	Bore.	Key.
3½"	2½"	¾"	3/16" square
3 "	2¼"	¾"	3/16" square
2½"	1¾"	⅝"	3/16" square

GROOVED PULLEYS.

Pitch Diam.	Belt Diam.	Bore	Set Screw.
2 "	5/16"	½"	5/16"—24 thread
1⅝"	5/16"	½"	5/16"—24 thread
1½"	¼"	⅜"	5/16"—24 thread

NOTE.—The 1⅝x5/16" pulley, when used with a ¼" belt, gives pulley dimensions of 1½"x¼". Groove pulley should be arranged for mounting upon the shaft provided with a flat and secured by a set screw.

(Adopted Standard 5-7-1920.)

(6272) Shaft Diameters.

Standard shaft diameter shall be as follows:

H. P.	Rated Speed	Shaft Extension Diameter
3/4	1725	¾-inch
1/2	1725	¾-inch
1/3	1725	⅝-inch
1/4	1725	⅝-inch
1/6	1725	½-inch
1/8	1725	½-inch
1/12	1725	½-inch
1/20	1725	⅜-inch

(Adopted Standard Revised 5-13-1915.)

(6273) Shaft Extensions.

The standard shaft extension for fractional horsepower motors shall be three times the shaft diameter.

(Recommended Practice 11-17-1920.)

Reference
Number

(6274) Tolerance Limits in Dimensions.

For belted type motors only, the allowable variation in the distance between the base of the motor and the center of the shaft, measured at the end of the shaft, shall be within the limits of plus 0 and minus 1/16-inch. (Adopted Standard Maximum and Minimum Limits 5-3-1916.)

(6275) Name Plate Marking.

The following minimum amount of information shall be given on all name plates:

(a) Manufacturers Type and Frame designation.
(b) Horse Power output.
(c) Time rating. (See Reference Number 5300.)
(d) Temperature rise.
(e) R.P.M. at full load.
(f) Frequency.
(g) No. of phases.
(h) Voltage.
(i) Full load amperes.

(Recommended Practice Revised 6-11-1917.)

(6278) Direction of Rotation.

For single phase motors see Reference Number 5401.

(6280) Terminals.

Terminals of Fractional Horsepower Motors shall consist of flexible single conductor leads brought out of the frame or bearing brackets of the motor through an insulated hole or holes, and any other form of connection shall be considered special and extra. Such terminals shall be approximately 9″ long for ¼ H.P. 1725 R. P. M. motors and smaller, and approximately 12″ long for sizes larger. (Adopted Standard 5-7-1920.)

(6281) Frame Designation.

The stationary element or the name plate of each motor shall be marked with the manufacturer's frame designation.

(Recommended Practice Revised 5-13-1915.)

LARGE POWER MOTORS — DIRECT CURRENT

(Motors 1 H. P. and larger. See definition Reference Number 1111)

Reference Number

(6315) RATING STANDARDS.

(6317) Voltage Standards.

Standard voltages shall be 115, 230 and 550 volts.

NOTE—See Ref. No. 6319 for voltage limitations for standard H. P. and speed ratings.

(Adopted Standard Revised 11-9-1914.)

(6319) Load, Speed and Voltage Ratings.

1. Standard load and speed ratings for open and semi-enclosed type continuous duty constant speed motors shall be as follows:

Table A

H.P. and Speed Ratings for General Application.

H.P.	R.P.M.	R.P.M.	R.P.M.	R.P.M.
¾		1150		
1	1750	"		
1½	"	"		
2	"	"		
3	"	"		
5	"	"	850	
7½	"	"	"	
10	"	"	"	
15	"	"	"	
20	"	"	"	575
25	"	"	"	"
30	"	"	"	"
40	"	"	"	"
50		"	"	"
60		"	"	"
75		"	"	"
100		"	"	"
125			"	"
150			"	"
200			"	"

Reference
Number
(6319 *Continued*)

Table B
H.P. and Speed Ratings for Direct Connection Only.

H.P.	R.P.M.	R.P.M.
50	1750	
60	"	
75	"	
100	"	
125	"	1150
150	"	"
200	"	"

Standard Voltage limits for the above are as follows:

115 volts from ¾ H.P. to 50 H.P., inclusive.
230 volts from ¾ H.P. to 200 H.P., inclusive.
550 volts from ¾ H. P. to 200 H. P., inclusive, but at this voltage the speed ratings will not conform definitely to listed speeds.

(Recommended Practice 5-7-1920.)

2. Standard load and speed ratings for adjustable speed open and semi-enclosed varying duty (machine tool) motors shall be as follows:

(a) Time Ratings for Machine Tool Motors.

Motors shall be given both a 60-minute and a continuous rating on the 50° basis, open and semi-enclosed, and on a 55° basis, enclosed. Both the 60-minute and the continuous rating shall be given on the nameplate. The horsepower ratings in this list shall be for 60-minute service and the continuous service horsepower ratings will be such as the motors will carry continuously at the temperature specified.

Reference
Number

(6319 *Continued*)

(b) H.P. and Speed Ratings for Machine Tool Motors.

	3 to 1			4 to 1	
H.P.	RPM	RPM	H.P.	RPM	RPM
2	700	2100	2	500	2000
3	650	1950	3	500	2000
5	650	1950	5	450	1800
7½	600	1800	7½	450	1800
10	600	1800	10	400	1600
15	550	1650	15	400	1600
20	500	1500	20	400	1600
25	500	1500	25	400	1600
35	500	1500	35	300	1200
50	400	1200	50	300	1200

Voltage ratings for the above motors shall be 230 and 550 volts.

(Recommended Practice 1-15-1919.)

(6320) Speed Limitations.

1. Belt. The following limitations represent good practice in belting motors under normal conditions to relatively high speed drives:

Limit use of 1800 or 1700 r.p.m. motors to a maximum of 40 H.P.

Limit use of 1500 r.p.m. motors to a maximum of 50 H.P.

Limit use of 1200 or 1150 r.p.m. motors to a maximum of 75 H.P.

Limit use of 900 or 850 r.p.m. motors to a maximum of 125 H.P.

The above limitations are based on the use of pulleys as standardized by The Electric Power Club. The limitations will be less than those given when motors are belted to slow speed drives, such as countershafts.

2. Gears. The following limitations represent good practice in gearing motors, based on the use of steel pinions:

Reference
Number

(6320 *Continued*)

Limit use of 1800 or 1700 r.p.m. motors to 5 H.P.

Limit use of 1500 r.p.m. motors to 10 H.P.

Limit use of 1200 or 1150 r.p.m. motors to 25 H.P.

Limit use of 900 or 850 r.p.m. motors to 50 H.P.

Limit use of 750 or 720 r.p.m. motors to 75 H.P.

3. **The use of outboard bearings** should be specified for general purpose motors with geared drive in frame sizes 75 H.P. 850 to 900 r.p.m. and larger. (Recommended Practice 11-17-1920.)

(6321) Short Time Ratings.

Standard short time ratings shall be 5, 10, 15, 30, 60 and 120 minutes. (See Reference Number 5300.) (Adopted Standard Revised 11-9-1915.)

(6322) Speed Ratios.

Standard speed ratios for adjustable speed motors shall be 1 to 1½, 1 to 2, 1 to 3, and 1 to 4.
(Adopted Standard 10-30-1911.)

(6330) PERFORMANCE SPECIFICATIONS.
(40° Rating Motors)

A 40° Rating motor is an open type motor having a 40° C. temperature rise guarantee under continuous operation with a two-hour 25 per cent overload guarantee at 55° C. Detailed temperature guarantees and complete performance specifications are given below in paragraphs Reference Numbers 6331 to 6349 inclusive. These apply to constant speed general purpose motors and adjustable speed and varying speed motors.
(Adopted Standard 11-18-1916.)

See Reference Number 5303 for descriptive statement of this and other ratings.

Reference
Number

(6331) Temperature Rise.

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the nameplate.

Class of insulation	A	
Load, per cent of rated capacity	100	125
Time rating	Continuous	2 hrs.
1. *Core and Windings*	40°	55°
2. *Commutator*		
a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
3. *Bare Copper Windings*	50°	65°
4. *Mechanical Parts*	*	*
*Temperature rise of all mechanical parts not in contact with the insulation may be such as will not be injurious in any respect.		

(Adopted Standard except item 2 to be Maximum Limit Revised 11-18-1916.)

For descriptive specification covering classes of insulation, see Reference Number 5301.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply, and deterioration of insulation may be expected if this ambient temperature is exceeded in regular operation.

Overload run immediately follows normal load run. See Reference Number 5302.

For descriptive specifications covering temperature ratings see Reference Number 5303.

Reference
Number

(6332) Overload.

Twenty-five per cent overload for two hours with the temperature guarantees given in Reference Number 6331.

Fifty per cent overload in torque momentarily without temperature guarantee.

(Adopted Standard Revised 11-18-1916.)

(6338) Change in Speed Due to Load.

The speed regulation of shunt wound constant speed continuous duty motors listed in Reference Number 6319-1, from full load to no load hot, shall not exceed 12% on motors ¾ to 5 horse power, inclusive, and 10% on larger motors, based on full load speeds.

(Adopted Standard 5-23-1919,
Amended 5-7-1920 and 11-15-1921.)

(6339) Change in Speed Due to Heating.

Variation in speed from full load cold to full load hot, during run of specified period, shall not exceed 10% based on full load speed hot.

(Adopted Standard 11-10-1915.)

(6340) Dielectric Test.

The standard dielectric test, except as specified below, shall be made by applying twice the normal voltage of the circuit to which the motor is connected, plus 1,000 volts. The A. C. test voltage is to be applied for one minute immediately after conclusion of the manufacturer's shop test. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. All windings, except that under test, shall be connected to ground. The frequency of the testing circuit shall be 60 cycles and the crest value of the test voltage shall be $\sqrt{2}$ times the specified test voltage.

Equivalent Shop Test

For all motors manufactured in large quantities and on which the A. C. test voltage is 2500 volts or less, an A.C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

(Adopted Standard Minimum Limit 5-3-1916.)

Reference Number

(6342) Efficiencies.

Conventional efficiencies are to be used in checking efficiency guarantees on large power motors.

(Adopted Standard 6-8-1921.))

(6343) Allowable Variation from Rated Voltage.

All motors shall operate successfully at normal rated load at any voltage not more than 10 per cent above or below the name plate rating, but not necessarily in accordance with the standards of performance established for operation at normal rating. See Reference Number 5002.

(Adopted Standard 11-18-1916.)

(6344) Allowable Variation from Rated Speed.

At normal operating temperature and voltage, the variation above or below rated speed shall not exceed 7½% for motors up to and including 7½ H. P.. 1150 R. P. M. For motors larger than 7½ H. P., 1150 R. P. M., this variation shall not exceed 5%,

(Adopted Standard 5-3-1916.)

(6349) General Guarantee.

See Reference Numbers 2001 to 2004 incl.

(6350) PERFORMANCE SPECIFICATIONS.

(50°, 55°, 70° and 75° Rating Motors)

Motors with these ratings are without overload temperature guarantee as distinguished from the 40° Rating, which has an overload temperature guarantee. (See Reference Number 6330.) Detailed temperature guarantees and complete performance specifications of the 50°, 55°, 70° and 75° Rating motors are given in Reference Numbers 6351 to 6369 inclusive. These apply to constant speed general purpose motors and adjustable speed and varying speed motors. (See Reference Number 5303 for descriptive statement of this and other ratings.)

(Adopted Standard 11-18-1916,
Amended 11-15-1921.)

Reference Number

(6351) Temperature Rise.

Temperature Rise in degrees centigrade when operating under normal conditions as specified on the nameplate.

Class of insulation	A	B
Load, per cent of rated capacity	100	100
Time rating *Time rating may be continuous or any standard short time rating. See Reference No. 6321	*	*
1. *Core and Windings*		
Fully enclosed motors.	55°	75°
All other types.	50°	70°
2. *Commutators*		
a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
3. *Bare Copper Windings*	60°	80°
3A. *Bare Copper Windings, Enclosed Motors* Provided the thermometer is applied directly to the surface of the bare copper winding.	65°	85°
4. *Mechanical Parts* †Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.	†	†

(Adopted Standard except item 2 to be Maximum Limit Revised 1-15-1919.)

For descriptive specification covering classes of insulation, see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see Reference Number 5303.

(6352) Overload.

Fifty per cent overload in torque momentarily without temperature guarantee.

(Adopted Standard 10-30-1911
Amended 11-15-1921.)

Reference Number

(6358) Change in Speed Due to Load.

The speed regulation of shunt wound constant speed continuous duty motors listed in Reference Number 6319-1, from full load to no load hot, shall not exceed 12% on motors ¾ to 5 horse power inclusive, and 10% on larger motors, based on full load speeds.

The speed regulation of shunt wound adjustable speed varying duty motors as listed in paragraph 6319-2, from full load to no load hot at any speed adjustment, shall not exceed 22% on motors of 2 to 5 horse power inclusive, and 15% on larger motors, based on full load speed.

(Adopted Standard 5-23-1919, Amended 5-7-1920 and 11-15-1921.)

(6359) Change in Speed Due to Heating.

Variation in speed from full load cold to full load hot, during run of specified period, shall not exceed 15% for enclosed motors, or 10% for all other types, based on full load speed hot.

(Adopted Standard Revised 11-18-1916.)

(6360) Dielectric Test.

See Reference Number 6340.

(6362) Efficiencies.

Conventional efficiencies are to be used in checking efficiency guarantees on large power motors.

(Adopted Standard 6-8-1921.)

(6363) Allowable Variation from Rated Voltage.

See Reference Number 6343.

(6364) Allowable Variation from Rated Speed.

See Reference Number 6344.

(6369) General Guarantee.

See Reference Numbers 2001 to 2004 inclusive.

Reference Number

(6370) STANDARD MANUFACTURING PRACTICE.

(6371) Pulley Dimensions.

Standard Pulley Dimensions applicable to either 40 deg. or 50 deg. motors shall be as follows, based on the use of paper pulleys:

H.P. at 1750-1800 R.P.M	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R.P.M.	Pulley Diam.	Belt Width	Bore
1	¾		3	2	¾
1½	1		4	3	⅞
2	1½		4	3	1
3	2		4	3	1
5	3		5	4	1⅛
7½	5	3	5	4	1¼
10	7½	5	6	5	1⅜
15	10	7½	7	6	1⅝
20	15	10	8	6	1¾
25			9	7	1⅞
30	20	15	9	7	1⅞
40	25—30	20—25	10	7	2⅛
	40	30	11	10	2⅜
	50		12	11	2⅝
	60	40	12	11	2⅝
	75	50	13	12	2⅞
		60	13	12	2⅞
	100	75	15	14	

(Recommended Practice 5-7-1920.)

Reference
Number

(6372) Shaft Extensions.

Shaft extension sizes for constant speed general purpose motors shall be as follows:

H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	Shaft Extension Diam. in Inches	Key Width	Key Thickness
1	¾	¾	3/16	3/16
1½	1	⅞	3/16	3/16
2	1½	1	¼	¼
3	2	1	¼	¼
5	3	1⅛	¼	¼
7½	5	1¼	¼	¼
10	7½	1⅜	⅜	⅜
15	10	1⅝	⅜	⅜
20	15	1¾	⅜	⅜
25		1⅞	½	½
30	20	1⅞	½	½
40	25—30	2⅛	½	½
50		2⅛	½	½
	40	2⅜	½	½
	50	2⅝	¾	½
	60	2⅝	¾	½
	75	2⅞	¾	½
	100			

In case other diameters are used on specific ratings the selection of one of the listed sizes is recommended. The standard length of shaft extensions shall be three times the diameter.

(Recommended Practice 12-12-1919,
Revised 5-7-1920.)

(6373) Taper Shafts.

See Reference Number 5400.

(6374) Tolerance Limits in Dimensions.

The dimensions from shaft center to bottom of feet shall not be greater than the nominal dimensions shown on manufacturers' dimension sheet. Where the motor is to be mounted on other machinery and exact height of shaft is required, it is expected that shims will be used to secure accurate alignment.

(Adopted Standard Maximum 1-15-1919.)

Reference Number

(6375) Name Plate Marking.

The following minimum amount of information shall be given on all nameplates:

(a) Manufacturers' type and frame designation.
(b) H. P. output.
(c) Time rating. (See Reference No. 5300.)
(d) Temperature rise—normal.
(e) Overload.
(f) Time Rating of overload.
(g) Temperature rise for overload.
(h) R. P. M. at full load.
(i) Voltage.
(j) Full load amperes.
(k) Shunt, series or compound.

(Adopted Standard Revised 11-18-1916.)

NOTE—Items (e), (f) and (g) refer to overloads for which temperature guarantees are given.

Item (a) shall be optional for all constant speed general purpose motors and adjustable speed motors.

(6378) Direction of Rotation.

See Reference Number 5401.

(Recommended Practice.)

(6380) Terminals for Cable Connections.

Terminals for cable connections shall be furnished as standard with frames whose open continuous duty rating is approximately 5 H.P. at 1700 R. P. M. and larger.

(Recommended Practice 11-10-1915.)

(6383) Outboard Bearings.

1. The use of outboard bearings should be specified for general purpose motors with geared drive in frame sizes 75 H. P., 850 to 900 R. P. M., and larger.

This does not apply to mill type motors or others designed for special service where the heavy construction avoids the necessity for the outboard bearings.

2. The use of outboard bearings is approved and recommended for belted general purpose motors in frame sizes 250 H. P., 580 to 600 R. P. M. and larger.

It is not the intention to establish a definite dividing line below which it is not proposed to use outboard bearings, but rather to establish a dividing line which will indicate to the motor user what the manufacturers consider as good practice in general service.

(Recommended Practice 5-3-1916.)

3. The use of outboard bearings is approved and recommended for general purpose motors with chain drive for frame sizes 75 H.P., 850 to 900 R.P.M., and larger.

(Recommended Practice 6-11-1917.)

LARGE POWER MOTORS — SINGLE PHASE

(Motors 1 H. P. and larger—see Definition Reference Number 1111)

Reference Number

(6401) Classification of Single Phase Motors.

1. Commutator Type.
   (a) With commutator for starting only—Constant Speed.
   (b) With commutator for starting and running—Constant Speed, Varying Speed.
2. Split Phase.
   (a) With clutch—Constant Speed.
   (b) Clutchless—Constant Speed.

(Adopted Standard 11-18-1916.)

(6415) RATING STANDARDS.

(6417) Voltage Ratings.

Standard voltages shall be 110 and 220 volts.

(Adopted Standard 6-8-1914.)

(6418) Frequencies.

Standard frequencies shall be 25 and 60 cycles per second. (Adopted Standard.)

Reference Number

(6419) Load and Speed Ratings.

Standard load and speed ratings for open and semi-enclosed continuous duty constant speed motors shall be:

60 Cycles H. P.	60 Cycles R. P. M.	25 Cycles H. P.	25 Cycles R. P. M.
¾	1200		
1	1800 — 1200	1	1500
1½	1800 — 1200	1½	1500
2	1800 — 1200	2	1500 — 750
3	1800 — 1200	3	1500 — 750
5	1800 — 1200 — 900	5	1500 — 750
7½	1800 — 1200 — 900	7½	1500 — 750
10	1800 — 1200 — 900	10	1500 — 750
15	1800 — 1200 — 900	15	1500 — 750
20	1800 — 1200 — 900	20	1500 — 750
25	1800 — 1200 — 900		
30	1800 — 1200 — 900		
40	1800 — 1200		
*50	1800		

Speeds given are synchronous speeds.

*For direct connection only.

(Recommended Practice 5-4-1916.)

(6430) PERFORMANCE SPECIFICATIONS.

(40° Rating Motors)

A 40° Rating motor is an open type motor having a 40° C. temperature rise guarantee under continuous operation with a two-hour 25 per cent overload guarantee at 55° C. Detailed temperature guarantees and complete performance specifications are given below in paragraphs Reference Numbers 6431 to 6449 inclusive. These apply to constant speed general purpose motors and adjustable speed and varying speed motors.

See Reference Number 5303 for descriptive statement of this and other ratings.

(Adopted Standard 11-18-1916,
Amended 11-15-1921.)

Reference
Number

(6431) Temperature Rise.

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the name plate.

Class of insulation	A	
Load, percent of rated capacity	100	125
Time rating	Continuous	2 hrs.
1. *Core and Windings*	40°	55°
2. *Squirrel Cage and Amortisseur Windings*	*	*
*Any value as will not occasion mechanical injury to the machine or cause deterioration of surrounding insulation.		
3. *Collector Rings*		
a. If Class A insulation is employed in the collector rings, or is adjacent thereto and its life would be affected by the heat from the collector rings.	65°	65°
b. If Class B insulation is employed in the collector rings or is adjacent thereto.	85°	85°
4. *Commutators*		
a. If Class A insulation is employed in the commutator or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
5. *Mechanical Parts*	**	**
**Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.		

(Adopted Standard, except items 3 and 4 are Maximum Limits Revised 11-18-1916.)

For descriptive specification covering classes of insulation, see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see Reference Number 5303.

Overload run immediately follows normal load run. See Reference Number 5302.

Reference
Number

(6432) Overload.

Twenty-five per cent overload for two hours with temperature guarantees given in Reference Number 6431. Fifty per cent overload in torque momentarily without temperature guarantee.

(Adopted Standard 10-30-1911.)

(6436) Starting Torque.

The starting torque of single phase motors, designed for repulsion start and induction running, with rated voltage and frequency applied, shall be not less than the following:

For 2 pole,	25 and	60 cycle	225%	of full load torque
4 "	"	"	200%	" " " "
6 "	"	"	175%	" " " "
8 "	"	"	150%	" " " "

(Adopted Standard 11-18-1916.)

(6437) Pull-in Torque.

The pull-in torque of single phase motors, designed for repulsion start and induction running, with rated voltage and frequency applied, shall be not less than 110 per cent of full-load torque.

(Adopted Standard 11-18-1916.)

(6438) Maximum Running Torque.

The pull-out or break-down torque of single phase motors, designed for repulsion start and induction running, with rated voltage applied, shall be not less than 175 per cent of full load torque.

(Adopted Standard 11-18-1916.)

(6440) Dielectric Tests.

Dielectric tests, except as specified below, shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1,000 volts. The specified A. C. test voltage shall be applied for one minute immediately after the conclusion of the manufacturer's shop test. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. Inter-connected circuits are considered as one circuit. All windings except that under test shall be connected to ground. Frequency of testing circuit shall be 60 cycles, and the crest value of the test voltage shall be $\sqrt{2}$ times the specified voltage. (Adopted Standard 11-18-1916.)

Reference
Number

(6440 *Continued*)

Equivalent Shop Test.

For all motors manufactured in large quantities and on which the A.C. test voltage is 2500 volts or less, an A.C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

(Adopted Standard Minimum Limit 11-18-1916.)

Exceptions: 1. The secondary windings of wound rotors not interconnected with stator windings shall be tested with twice their normal induced voltage, plus 1,000 volts.

(Adopted Standard Minimum Limit 11-18-1916.)

(6442) Efficiency.

Conventional efficiencies are to be used in checking efficiency guarantees on large power motors.

(Adopted Standard 6-8-1921.)

(6443) Allowable Variation from Rated Voltage.

Motors shall operate successfully at rated load and frequency, with voltage not more than 10 per cent above or below the name-plate rating, but not necessarily in accordance with the standards established for operation at normal rating.

See No. 5002. (Adopted Standard 11-18-1916.)

(6444) Allowable Variation from Rated Frequency.

Motors shall operate successfully at rated load and voltage, with frequencies not more than 5 per cent above or below the name-plate rating, but not necessarily in accordance with the standards established for operation at normal rating.

See No. 5002. (Adopted Standard 11-18-1916.)

(6445) Allowable Combined Variation of Voltage and Frequency.

All motors shall operate successfully at rated load with a combined variation of voltage and frequency not more than 10 per cent above or below the name-plate rating, provided the variations given in Reference Numbers 6443 and 6444 are not exceeded, but not necessarily in accordance with the standards established for operation at normal rating.

(Adopted Standard 11-18-1916.)

See Reference Number 5002.

Reference
Number

(6449) General Guarantee.

See Reference Numbers 2001 to 2004 inclusive.

(6450) PERFORMANCE SPECIFICATIONS.
(50°, 55°, 70° and 75° Rating Motors)

Motors with these ratings are without overload temperature guarantee as distinguished from the 40° Rating motors which have an overload guarantee. (See Reference Number 6430.) Detailed temperature guarantees and complete performance specifications of 50°, 55°, 70° and 75° Rating motors are given in Referenme Numbers 6451 to 6469 inclusive. These apply to constant speed general purpose motors, and adjustable speed and varying speed motors.

(Adopted Standard 11-18-1916,
Amended 11-15-1921.)

Reference
Number

(6451) Temperature Rise.

Temperature Rise in degrees centigrade when operating under normal conditions as specified on the name plate.

Class of insulation	A	B
Load, percent of rated capacity	100	100
Time rating *Time rating may be continuous or any standard short time rating. See No. 5300.	*	*
1. *Core and Windings*		
a. Fully enclosed motors.	55°	75°
b. All other types.	50°	70°
2. *Squirrel Cage and Amortisseur Windings* **Any value as will not occasion mechanical injury to the machine or cause deterioration of surrounding insulation.	**	**
3. *Collector Rings*		
a. If Class A insulation is employed in the collector rings, or is adjacent thereto and its life would be affected by the heat from the collector rings.	65°	65°
b. If Class B insulation is employed in the collector rings, or is adjacent thereto.	85°	85°
4. *Commutators*		
a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
5. *Mechanical Parts* †Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.	†	†

(Adopted Standard, except Items 3 and 4, to be Maximum Limits 11-18-1916.)

For descriptive specification covering classes of insulation see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply, and deterioration of insulation may be expected if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see Reference Number 5303.

Reference
Number

(6452) Overload.

Fifty per cent overload in torque momentarily without temperature guarantee.

(Adopted Standard 11-18-1916.)

(6456) Starting Torque.

For starting torque of continuous duty motors, see Reference Number 6436.

(6457) Pull-in Torque.

For pull-in torque of continuous duty motors, see Reference Number 6437.

(6458) Maximum Running Torque.

For maximum running torque of continuous duty motors, see Reference Number 6438.

(6460) Dielectric Tests.

See Reference Number 6440.

(6462) Efficiency.

Conventional efficiencies are to be used in checking efficiency guarantees on large power motors.

(Adopted Standard 6-8-1921.)

(6463) Allowable Variation from Rated Voltage.

See Reference Number 6443.

(6464) Allowable Variation from Rated Frequency.

See Reference Number 6444.

(6465) Allowable Combined Variation from Rated Voltage and Frequency.

See Reference Number 6445.

(6469) General Guarantee.

See Reference Numbers 2001 to 2004 inclusive.

Reference
Number

(6470) STANDARD MANUFACTURING PRACTICE.

(6471) Pulley Dimensions.

Standard Pulley Dimensions applicable to either 40 deg. or 50 deg. motors shall be as follows, based on the use of paper pulleys:

H.P. at 1750-1800 R.P.M	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R.P.M.	Pulley Diam.	Belt Width	Bore
1	¾		3	2	¾
1½	1		4	3	⅞
2	1½		4	3	1
3	2		4	3	1
5	3		5	4	1⅛
7½	5	3	5	4	1¼
10	7½	5	6	5	1⅜
15	10	7½	7	6	1⅝
20	15	10	8	6	1¾
25			9	7	1⅞
30	20	15	9	7	1⅞
40	25—30	20—25	10	7	2⅛
	40	30	11	10	2⅜
	50		12	11	2⅝
	60	40	12	11	2⅝
	75	50	13	12	2⅞
		60	13	12	2⅞
	100	75	15	14	

(Recommended Practice 5-7-1920.)

(6472) Shaft Extensions.

Shaft extension sizes for constant speed general purpose motors shall be as follows:

H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	Shaft Extension Diam. in Inches	Key Width	Key Thickness
1	¾	¾	$\frac{3}{16}$	$\frac{3}{16}$
1½	1	⅞	$\frac{3}{16}$	$\frac{3}{16}$
2	1½	1	¼	¼

Reference Number

(6472 *Continued*)

H.P. at 1750-1800 R,P.M.	H.P. at 1150-1200 R.P.M.	Shaft Extension Diam. in Inches	Key Width	Key Thickness
3	2	1	¼	¼
5	3	1⅛	¼	¼
7½	5	1¼	¼	¼
10	7½	1⅜	⅜	⅜
15	10	1⅝	⅜	⅜
20	15	1¾	⅜	⅜
25		1⅞	½	½
30	20	1⅞	½	½
40	25—30	2⅛	½	½
50		2⅛	½	½
	40	2⅜	½	½
	50	2⅝	¾	½
	60	2⅝	¾	½
	75	2⅞	¾	½
	100			

In case other diameters are used on specific ratings the selection of one of the listed sizes is recommended. The standard length of shaft extensions shall be three times the diameter.

(Recommended Practice 12-12-1919, Revised 5-7-1920.)

(6473) Taper Shafts.

See Reference Number 5400.

(6474) Tolerance Limits in Dimensions.

The dimensions from shaft center to bottom of feet shall not be greater than the nominal dimensions shown on manufacturers' dimension sheet. Where the motor is to be mounted on other machinery and exact height of shaft is required, it is expected that shims will be used to secure accurate alignment.

(Adopted Standard 1-15-1919.)

Reference Number

(6475) Name Plate Markings.

The following minimum amount of information shall be given on all name plates:

1. Motors without controller in secondary circuit.
   - (a) Manufacturers' type and frame designation.
   - (b) H. P. output.
   - (c) Time rating. (See Reference Number 5300.)
   - (d) Temperature rise—normal.
   - (e) Overload.
   - (f) Time Rating of overload.
   - (g) Temperature rise for overload.
   - (h) R. P. M. at full load.
   - (i) Frequency.
   - (j) Number of phases.
   - (k) Voltage.
   - (l) Full load amperes.
2. Motors with controller in secondary circuit.
   - (a-l) Same as above.
   - (m) Secondary amperes at full load.

Items (e), (f) and (g) refer to overloads for which temperature guarantees are given.

Item (a) shall be optional.

(Adopted Standard Revised 11-18-1916.)

(6478) Direction of Rotation.

See Reference Number 5401.

LARGE POWER MOTORS—POLYPHASE

(Motors 1 H. P. and larger—see definition Reference Number 1111.)

Reference Number

(6501) Classification of Polyphase Motors.

1. Induction Motors:
    (a) Squirrel cage.
    (b) Slip ring.
    (c) Polar wound internally short circuited rotor.
2. Synchronous Motors.

(Adopted Standard 1-15-1919.)

(6515) RATING STANDARDS.

(6516) Basis of Rating Elevator Motors.

1. Squirrel Cage Elevator Motors shall be rated primarily on the basis of guaranteed starting torque; they may also be given a H. P. rating. The H. P. Rating shall be the brake H. P. the motor will actually develop without exceeding the standard temperature rise for the standard time rating selected.

(Adopted Standard 5-4-1916.)

(6517) Voltage Ratings.

Standard voltages shall be 110, 220, 440, 550 and 2200 volts.

NOTE—See Reference Number 6519 for voltage limitations for various H. P. and speed ratings.

(Adopted Standard 5-30-1911.)

(6518) Frequencies.

Standard frequencies shall be 25 and 60 cycles per second. (Adopted Standard.)

(6519) Load and Speed Ratings.

Standard load and speed ratings for open and semi-enclosed continuous duty constant speed motors shall be:

Reference
Number

(6519 *Continued*)

H. P. AND SPEED RATINGS FOR GENERAL APPLICATION.

Number of Poles	60 Cycle 4	6	8	10	12	16	25 Cycle 2	4	6
H. P.									
½								750	
¾		1200						"	
1	1800	"					*1500	"	
1½	"	"					"	"	
2	"	"					"	"	
3	1800	1200	900				*1500	750	
5	"	"	"				"	"	
7½	"	"	"				"	"	
10	"	"	"		600		"	"	500
15	"	"	"		"		"	"	"
20	"	"	"		"		"	"	"
25	"	"	"		"		"	"	"
30	"	"	"		"		"	"	"
40	"	"	"		"		"	"	"
50		"	"		"		"	"	"
60		"	"		"		"	"	"
75		"	"		"			"	"
100		"	"		"	450		"	"
125			"	720	"	"		"	"
150			"	"	"	"		"	"
200			"	"	"	"		"	"

FOR DIRECT CONNECTION ONLY.

No. of Poles H.P.	60 Cycles. 4 RPM	6 RPM	25 Cycles. 2 RPM
50	1800		
60	"		
75	"		1500
100	"		"
125	"	1200	"
150	"	"	"
200	"	"	"

The speeds given are synchronous speeds.

*1500 R.P.M. motors are for squirrel cage type only.

Standard Voltage Limits for the above as follows:

110 volts from ½ H.P. to 5 H.P., inclusive.
220 and 440 volts from ½ H.P. to 200 H.P., inclusive.
550 volts from ¾ H.P. to 200 H.P., inclusive.
2200 volts from 30 to 200 H.P., inclusive.

(Recommended Practice Revised 1-15-1919.)

Reference
Number

(6520) Speed Limitations.

1. Belt. The following limitations represent good practice in belting motors under normal conditions to relatively high speed drives:

Limit use of 1800 or 1700 r.p.m. motors to a maximum of 40 H.P.

Limit use of 1500 or 1440 r.p.m. motors to a maximum of 50 H.P.

Limit use of 1200 or 1150 r.p.m. motors to a maximum of 75 H.P.

Limit use of 900 or 850 r.p.m. motors to a maximum of 125 H.P.

The above limitations are based on the use of pulleys as standardized by The Electric Power Club. The limitations will be less than those given when motors are belted to slow speed drives, such as countershafts.

2. Gear. The following limitations represent good practice in gearing motors, based on the use of steel pinions:

Limit use of 1800 or 1700 r.p.m. motors to 5 H.P.

Limit use of 1500 or 1440 r.p.m. motors to 10 H.P.

Limit use of 1200 or 1150 r.p.m. motors to 25 H.P.

Limit use of 900 or 850 r.p.m. motors to 50 H.P.

Limit use of 750 or 720 r.p.m. motors to 75 H.P.

The use of outboard bearings should be specified for general purpose motors with geared drive in frame sizes 75 H.P. 850 to 900 r.p.m. and larger.

(Recommended Practice 11-17-1920.)

(6530) PERFORMANCE SPECIFICATIONS.
(40° Rating Motors)

A 40° Rating motor is an open type motor having a 40° C. temperature rise guarantee under continuous operation with a two-hour 25 per cent overload guarantee at 55° C. Detailed temperature guarantees and complete performance specifications are given below in paragraphs Nos. 6531 to 6549 inclusive. These apply to constant speed general purpose motors and adjustable speed multispeed and varying speed motors.

See Reference Number 5303 for descriptive statement of this and other ratings.

(Adopted Standard 11-18-1916,
Amended 11-15-1921.)

Reference
Number

(6531) Temperature Rise.

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the name plate.

Class of insulation	A	
Load, percent of rated capacity	100	125
Time rating	Continuous	2 hrs.
1. *Core and Windings*	40°	55°
2. *Squirrel Cage and Amortisseur Windings* *Any value as will not occasion mechanical injury to the machine or cause deterioration of surrounding insulation.	*	*
3. *Collector Rings*		
a. If Class A insulation is employed in the collector rings, or is adjacent thereto and its life would be affected by the heat from the collector rings.	65°	65°
b. If Class B insulation is employed in the collector rings or is adjacent thereto.	85°	85°
4. *Commutators*		
a. If Class A insulation is employed in the commutator or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
5. *Mechanical Parts* **Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.	**	**

(Adopted Standard, except items 3 and 4 to be Maximum Limits, Revised 11-18-1916.)

For descriptive specification covering classes of insulation, see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see Reference Number 5303.

Overload run immediately follows normal load run. See Reference Number 5302.

Reference Number

(6532) Overload.

Twenty-five per cent overload for two hours with temperature guarantees given in Reference Number 6531.

Fifty per cent overload momentarily in torque without temperature guarantee.

(Adopted Standard Revised 11-18-1916.)

(6536) Starting Torque.

The starting torque of squirrel cage motors with rated voltage applied, at the instant of starting from rest, shall be not less than the following:

For 2 pole,	25 or 60	cycle motors	150%	of full load	torque
4 "	"	"	150%	"	"
6 "	"	"	135%	"	"
8 "	"	"	125%	"	"
10 "	"	"	120%	"	"
12 "	"	"	115%	"	"
14 "	"	"	110%	"	"

With rated voltage applied, the torque shall at all speeds from zero to full load speed be not less than full-load torque.

(Adopted Standard Revised 5-23-1919.)

(6538) Maximum Running Torque.

The pull-out or break-down torque, with rated voltage applied, shall be not less than 200 per cent of full-load torque.

(Adopted Standard Minimum Limit 11-18-1916.)

(6540) Dielectric Tests.

Dielectric test, except as specified below, shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1000 volts. The specified A. C. test voltage is to be applied for one minute immediately after the conclusion of the manufacturer's shop test. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. Inter-connected polyphase windings are considered as one circuit. All windings except

Reference
Number

(6540 *Continued*)

that under test shall be connected to ground. Frequency of the testing circuit shall be 60 cycles and the crest value of the test voltage shall be $\sqrt{2}$ times specified voltage.

(Adopted Standard 5-4-1916.)

Exceptions:

1. Field windings of synchronous motors which are to be started from alternating current circuits shall be tested as follows:

(a) When motors are started with fields short circuited, field windings shall be tested with 10 times the exciter voltage, but in no case less than 1500 volts nor more than 3500 volts.

(b) When motors are started with fields open circuited and sectionalized while starting, the field windings shall be tested with 5000 volts.

(c) When motors are started with fields open circuited and connected all in series while starting, the field windings shall be tested with 5000 volts for less than 275 volts excitation and 8000 volts for excitation of 275 volts to 750 volts.

2. The secondary windings of wound rotors of induction motors shall be tested with twice their normal induced voltage, plus 1000 volts. When induction motors with phase wound rotors are reversed while running at approximately normal speed, by reversing the primary connections, the test shall be 4 times the normal induced voltage, plus 1000 volts.

Equivalent Shop Test

For all motors manufactured in large quantities and on which the A. C. test voltage is 2500 volts or less, an A.C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

(6541) Commercial Tests.

Same as Reference Number 6561.

(6542) Efficiencies.

Same as Reference Number 6562.

(6543) Allowable Variation from Rated Voltage.

All motors shall operate successfully at rated load and frequency with voltage not more than 10 per cent above or below name-plate rating, but not necessarily in accordance with the standards established for operation at normal rating. (See Reference Number 5002.)

(Adopted Standard 11-18-1916.)

Reference Number

(6544) Allowable Variation from Rated Frequency.

All motors shall operate successfully at rated load and voltage, with frequencies not more than 5 per cent above or below the name-plate rating, but not necessarily in accordance with the standards established for operation at normal rating. (See Reference Number 5002.)

(Adopted Standard 11-18-1916.)

(6545) Allowable Combined Variation of Voltage and Frequency.

All motors shall operate successfully at rated load with combined variation in voltage and frequency not more than 10 per cent above or below the name-plate rating, provided the limits of variations given in Nos. 6543 and 6544 are not exceeded, but not necessarily in accordance with the standards established for operation at normal rating. (See Reference Number 5002.)

(Adopted Standard 11-18-1916.)

(6549) General Guarantee.

See Reference Numbers 2001 to 2004.

(6550) PERFORMANCE SPECIFICATIONS.

(50°, 55°, 70° and 75° Rating Motors)

Motors with these ratings are without overload temperature guarantee as distinguished from the 40° Rating motors which have an overload guarantee (See Reference Number 6530). Detailed temperature guarantees and complete performance specifications of 50°, 55°, 70° and 75° rating motors are given in Reference Numbers 6551 to 6569 inclusive. These apply to constant speed general purpose motors and adjustable speed, multispeed and varying speed motors. (See Reference Number 5303 for descriptive statement of all ratings.

(Adopted Standard 11-18-1916, Amended 11-15-1921.)

Reference
Number

(6551) Temperature Rise.

Temperature Rise in degrees centigrade when operating under normal conditions as specified on the name plate.

Class of insulation	A	B
Load, percent of rated capacity	100	100
Time rating *Time rating may be continuous or any standard short time rating. See No. 5300.	*	*
1. *Core and Windings*		
a. Fully enclosed motors.	55°	75°
b. All other types.	50°	70°
2. *Squirrel Cage and Amortisseur Windings* **Any value as will not occasion mechanical injury to the machine or cause deterioration of surrounding insulation.	**	**
3. *Collector Rings*		
a. If Class A insulation is employed in the collector rings, or is adjacent thereto and its life would be affected by the heat from the collector rings.	65°	65°
b. If Class B insulation is employed in the collector rings, or is adjacent thereto.	85°	85°
4. *Commutators*		
a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
5. *Mechanical Parts* †Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.	†	†

Adopted Standard, except Items 3 and 4, to be Maximum Limits 11-18-1916.)

For descriptive specification covering classes of insulation see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply, and deterioration of insulation may be expected if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see Reference Number 5303.

Reference
Number

(6552) Overload.

Fifty per cent overload momentarily in torque without temperature guarantee.

(Adopted Standard 5-30-1911.)

(6556) Starting Torque.

For starting torque of continuous duty motors, see Reference Number 6536.

(6558) Maximum Running Torque.

For maximum running torque of continuous duty motors, see Reference Number 6538.

(6561) Commercial Tests.

(1) Dielectric tests as per Reference Number 6540.

(2) All other tests—

(a) Idle readings on all machines at normal voltage.

(b) Locked readings on all machines at fractional voltage. (Direct load test may be substituted for the locked test when the capacity of test equipment permits.)

(c) Resistance readings on first three machines built to specifications. (Check tests made from time to time at intervals to be decided upon by each manufacturer.)

(d) Measurement of open circuit voltage ratio on all wound rotor motors. (Check tests made from time to time as determined by each manufacturer.)

(e) Temperature test and speed curve of the first machine of each specification. (Check tests on standard specification will be made from time to time as determined by each manufacturer.)

(Recommended Practice 6-8-1921.)

Reference
Number

(6562) Efficiencies.

Conventional efficiencies are to be used in checking efficiency guarantees on large power motors.

(Adopted Standard 6-8-1921.)

(6563) Allowable Variation from Rated Voltage.

See Reference Number 6543.

(6564) Allowable Variation from Rated Frequency.

See Reference Number 6544.

(6565) Allowable Combined Variation from Rated Voltage and Frequency.

See Reference Number 6545.

(6569) General Guarantee.

See Reference Numbers 2001 to 2004 inclusive.

(6570) STANDARD MANUFACTURING PRACTICE.

(6571) Pulley Dimensions.

Standard Pulley Dimensions applicable to either 40 deg. or 50 deg. motors shall be as follows, based on the use of paper pulleys:

H.P. at 1750-1800 R.P.M	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R.P.M.	Pulley Diam.	Belt Width	Bore
1	¾		3	2	¾
1½	1		4	3	⅞
2	1½		4	3	1
3	2		4	3	1
5	3		5	4	1⅛
7½	5	3	5	4	1¼
10	7½	5	6	5	1⅜
15	10	7½	7	6	1⅝
20	15	10	8	6	1¾
25			9	7	1⅞
30	20	15	9	7	1⅞
40	25—30	20—25	10	7	2⅛

Reference Number

(6571 *Continued*)

H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R P.M.	Pulley Diam.	Belt Width	Bore
	40	30	11	10	2⅜
	50		12	11	2⅝
	60	40	12	11	2⅝
	75	50	13	12	2⅞
		60	13	12	2⅞
	100	75	15	14	

(Recommended Practice 5-7-1920.)

(6572) Shaft Extensions.

Shaft extension sizes for constant speed general purpose motors shall be as follows:

H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	Shaft Extension Diam. in Inches	Key Width	Key Thickness
1	¾	¾	3/16	3/16
1½	1	⅞	3/16	3/16
2	1½	1	¼	¼
3	2	1	¼	¼
5	3	1⅛	¼	¼
7½	5	1¼	¼	¼
10	7½	1⅜	⅜	⅜
15	10	1⅝	⅜	⅜
20	15	1¾	⅜	⅜
25		1⅞	½	½
30	20	1⅞	½	½
40	25—30	2⅛	½	½
50		2⅛	½	½
	40	2⅜	½	½
	50	2⅝	¾	½
	60	2⅝	¾	½
	75	2⅞	¾	½
	100			

In case other diameters are used on specific ratings the selection of one of the listed sizes is recommended. The standard length of shaft extensions shall be three times the diameter.

(Recommended Practice 12-12-1919,
Revised 5-7-1920.)

Reference
Number

(6573) Taper Shafts.

See Reference Number 5400.

(6574) Tolerance Limits in Dimensions.

The dimensions from shaft center to bottom of feet shall not be greater than the nominal dimensions shown on manufacturers' dimension sheet. Where the motor is to be mounted on other machinery, and exact height of shaft is required, it is expected that shims will be used to secure accurate alignment. (Adopted Standard 1-15-1919.)

(6575) Name Plate Marking.

The following minimum amount of information shall be given on all name plates:

1. Induction Motors:
    - (a) Manufacturer's type and frame designation.
    - (b) H. P. output.
    - (c) Time rating—See Reference Number 5300.
    - (d) Temperature rise—normal.
    - (e) Overload.
    - (f) Time rating of overload.
    - (g) Temperature rise for overload.
    - (h) R. P. M. at full load.
    - (i) Frequency.
    - (j) Number of phases.
    - (k) Voltage.
    - (l) Full load amperes.

    (Adopted Standard Revised 11-18-1916.)

    NOTE—Item (a) shall be optional.
2. Wound Rotor Induction Motors:
    - (a-l) Same as above.
    - (m) Secondary amperes at full load.

    (Adopted Standard Revised 11-18-1916.)

    NOTE—Item (a) shall be optional.
3. Synchronous Motors:
    - (a-l) Same as above.
    - (m) Maximum exciting current in amperes required to maintain the rated power factor and rated load.
    - (n) Excitation pressure in volts.

    (Adopted Standard Revised 11-18-1916.)

    NOTE—Item (a) shall be optional.

Items (e), (f) and (g) refer to overloads for which temperature guarantees are given.

Reference
Number

(6575 *Continued*)

4. Squirrel Cage High Torque Elevator Motors:
   (a) Manufacturers type designation.
   (b) H.P. rating (optional).
   (c) Time rating. See No. 5300.
   (d) Temperature rise (normal).
   (e) R.P.M. at full load.
   (f) Starting torque (lbs. at 1 ft.).
   (g) Frequency.
   (h) No. of phases.
   (i) Voltage.
   (j) Full load amperes.

(Adopted Standard Revised 11-12-1917.)

NOTE—Item (a) shall be optional.

(6580) Terminals for Cable Connections.

Terminals for cable connections shall be furnished as standard practice with frames whose open continuous duty rating is approximately 5 H. P. at 1700 R. P. M. and larger.

(Recommended Practice 11-10-1915.)

(6583) Outboard Bearings.

1. The use of outboard bearings should be specified for general purpose motors with geared drive for frame sizes, 75 H.P., 850 to 900 R.P.M. and larger.

This does not apply to mill type motors or others designed for special service where heavy construction avoids the necessity for outboard bearings.

(Recommended Practice Revised 6-11-1917.)

2. The use of outboard bearings is approved and recommended for belted general purpose motors in frame sizes, 250 H. P., 580 to 600 R. P. M. and larger.

(Recommended Practice 5-4-1916.)

It is not the intention to establish a definite dividing line below which it is not proposed to use outboard bearings, but rather to establish a dividing line which will indicate to the motor user what the manufacturers consider as good practice in general service.

3. The use of outboard bearings is approved and recommended for general purpose motors with chain drive for frame sizes, 75 H.P., 850 to 900 R.P.M.. and larger.

(Recommended Practice 6-11-1917.)

GENERATORS — DIRECT CURRENT

Reference Number

(6615) RATING STANDARDS

(6616) Basis of Rating.

1. *Two-Wire Generators.*

The generator shall be rated in amperes corresponding to its standard voltage. Since the heating of the generator depends upon its current, the ampere ratings should not vary with any change in voltage on the standard machines. Example: A 50 kw. 250 volt generator has a normal capacity of 200 amperes. If such a machine is sold to operate at 235 volts either with reduction in speed or field excitation the rated current capacity will still be 200 amperes

(Adopted Standard 5-20-1912.)

2. *Three-Wire Generators.*

The ampere rating of a three-wire generator shall correspond to the ampere rating of a two-wire machine having an equal output at the same voltage. When such a generator is running with an unbalanced load, it shall be considered as delivering its rated load when the current on the more heavily loaded side is equal to the rated ampere output of the machine. The value of current in the neutral, or amount of unbalance, shall be expressed as a percentage of the rated load of the generator in amperes. A three-wire generator shall have a current capacity in the neutral of 10% of its rated capacity without exceeding the specified temperature limits.

(Adopted Standard Minimum Limit
Revised 5-2-1916.)

(6617) Voltage Ratings.

Standard voltages for general purpose generators shall be 125 and 250 volts at full load.

(Adopted Standard 5-7-1920.)

NOTE 1.—For 550 volt motor service generator of 600 volts at full load is recommended.

(Recommended practice 5-7-1920.)

NOTE 2.—For coal mine service, generator voltage of 275 volts at full load is recommended.

(Recommended practice 5-7-1920.)

Reference
Number

(6630) PERFORMANCE SPECIFICATIONS.

(40° Rating Generators)

(6631) Temperature Rise.

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the name plate.

a. *TWO-WIRE GENERATORS.*

Class of insulation	A	
Load, percent of rated current capacity	100	125
Time rating	Continuous	2 hrs.
1. *Core and Windings*	40°	55°
2. *Commutator*	45°	60°

b. *THREE-WIRE GENERATORS.*

The temperature guarantees specified for two wire generators shall apply to three-wire generators, and to any auxiliary windings or devices required in adapting them to three-wire service. These temperature guarantees shall apply to such generator wheather carrying either a balanced or unbalanced load.

(Recommended Practice 5-20-1912.)

For descriptive specification covering classes of insulation see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002 for restrictions in this connection.

Overload run immediately follows normal load run. See Reference Number 5302.

(6632) Overload.

Twenty-five per cent overload for 2 hours with temperature guarantee as given in Reference Number 6631. Fifty per cent momentarily without temperature guarantee.

(Adopted Standard 5-20-1912.)

Reference Number

(6633) Commutation.

A generator shall commutate throughout its range of rated capacity without adjustment of its brushes, and in such manner that neither brushes nor commutator are injured.

(Adopted Standard 5-20-1912.)

(6634) Compounding.

Standard general purpose generators shall have compound windings such as to give, when operating at constant speeds, terminal voltages respectively as follows:

120 volts no load	125 volts full load
240 " " "	250 " " "
575 " " "	600 " " "

(Recommended Practice 5-7-1920.)

NOTE.—Generators for coal mine service shall be wound for 250 volts no load, 275 volts full load.

(Recommended Practice 5-7-1920.)

(6635) Voltage Regulation.

The voltage regulation of a three-wire generator shall be such that when operating at rated current (on the heavier loaded side) and voltage and carrying in the neutral 10% of its rated amperes, the resulting difference in voltage between the two sides of the circuit will not exceed 2% of the normal rated voltage across the outside mains.

(Adopted Standard Maximum Limit, Revised 5-7-1920.)

(6640) Dielectric Test.

The dielectric test for general purpose direct current generators shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1,000 volts. (A. I. E. E. 2356.)

(Adopted Standard Minimum Limit 5-2-1916.)

Reference Number

(6648) Efficiency.

1. Conventional Efficiency shall be employed as distinguished from Directly-Measured Efficiency, (1916 Revision A. I. E. E. Rules Nos. 422 and 423.)
(Adopted Standard 11-18-1916.)

2. All losses enumerated in A. I. E. E. Rule No. 440 (1916 Revision) shall be included and shall be determined as provided therein.

3. Efficiencies shall correspond to or be corrected to normal standard conditions and corrected at all loads to a reference temperature of 75° C. (See 1916 Revision A. I. E. E. Rules Nos. 427 and 432.)

4. In determining the efficiency of a three-wire generator, all losses inherent in any auxiliary windings or devices required in adapting it to three-wire service shall be included as a part of the generator losses. Efficiency figures shall be determined on the basis of balanced load.
(Adopted Standard 5-20-1912.)

(6649) General Guarantee.

See Reference Numbers 2001 to 2004, inclusive.

(6650) PERFORMANCE SPECIFICATIONS.

(50° Rating Generators)

Generators with this rating are without overload temperature guarantees as distinguished from the 40° Rating which has an overload temperature guarantee (see Reference Number 6630). Detailed temperature guarantees and complete performance specifications of the 50° Rating are given as follows in Reference Numbers 6651 to 6669 inclusive.
(Adopted Standard 11-15-1921.)

Reference Number

(6651) Temperature Rise.

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the name plate.

1. *TWO-WIRE GENERATORS.*

Class of Insulation	A
Load, percent of rated current capacity	100
Time rating	Continuous
Temperature Rise	
A. *Core and Windings—Open Types*	50°
B. *Commutators*	
a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator.	65°
b. In all other cases.	85°
C. *Bare Copper Windings* Provided the thermometer is applied directly to the surface of the bare copper winding.	60°
D. *Mechanical Parts* †Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.	†

2. *THREE-WIRE GENERATORS.*

The temperature guarantees specified for two-wire generators shall apply to three-wire generators, and to any auxiliary windings or devices required in adapting them to three-wire service. These temperature guarantees shall apply to such a generator whether carrying either a balanced or unbalanced load.

(Adopted Standard 11-15-1921.)

For descriptive specifications covering classes of insulation see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002 for restrictions in this connection. General guarantees do not apply, and deterioration of insulation may be expected if this ambient temperature is exceeded in regular operation.

Reference
Number

(6652) Overload.

Generators shall carry a momentary load of 150% of the normal ampere rating, the rheostat being set for rated load excitation.

(Adopted Standard 11-15-1921.)

(6653) Commutation.

See Reference Number 6633.

(6660) Dielectric Test.

See Reference Number 6640.

(6668) Efficiency.

See Reference Number 6648.

(6669) General Guarantee.

See Reference Numbers 2001 to 2004 inclusive.

(6670) STANDARD MANUFACTURING PRACTICE.

(6673) Bore of Armature Spiders.

Standard bores of armature spiders for engine type generators shall be:

		Side Crank	Center Crank
25 kw.	325 R.P.M.	4½"	4"
35 kw.	300 R.P.M.	5½"	4"
50 kw.	275 R.P.M.	6½"	4½"
75 kw.	275 R.P.M.	7½"	5½"
100 kw.	250 R.P.M.	8½"	6"
125 kw.	250 R.P.M.	8½"	6"
150 kw.	200 R.P.M.	10"	7"
150 kw.	150 R.P.M.	11"	8"
200 kw.	200 R.P.M.	11"	8"
200 kw.	150 R.P.M.	11"	8"
250 kw.	200 R.P.M.	13"	8"

NOTE—The standardization of load and speed ratings is under consideration and is not covered in rule.

(Recommended Practice 6-8-1914.)

Reference
Number

(6675) Name Plate Markings.

The following minimum amount of information shall be given on all name plates:

(a) Manufacturer's type designation and frame number.
(b) Kw. output.
(c) Time rating. (See Reference Number 5300.)
(d) Temperature rise—normal
(e) Overload.
(f) Time rating of overload.
(g) Temperature rise for overload.
(h) Rated speed in R. P. M.
(i) Rated voltage*.
(j) Rated current in amperes.
(k) Winding—series, shunt or compound.

(Adopted Standard 11-18-1916.)

*Both full load and no load voltage to be given for compound wound generators.

Items (e), (f) and (g) refer to overloads for which temperature guarantees are given.

Item (a) shall be optional.

(6678) Direction of Rotation.

See Reference Number 5401.

(6690) STANDARD COMMERCIAL PRACTICE.

(6691) Charges for Special Bores.

See Reference Number 2006.

(6692) Charges for Witness Test.

See Reference Number 2015.

(6693) Charges for Pressing Armature on Engine Shaft.

See Reference Number 2007.

Reference
Number

Isolated Electric Farm Lighting Plants

(6696) GENERAL SPECIFICATIONS.

1. It is recognized that there are three general types of plants used, viz.: (a) those which furnish power from the generator alone; (b) those which furnish power from generator and battery combined or from battery alone; (c) those which furnish power from generator and battery combined or from either generator or battery alone.

2. It is recognized that there are two general types of storage battery in use, viz.: (a) the lead type, and (b) the nickel, alkaline or Edison type. It is recommended that for 32 volt service 16 cells lead type or 24 cells Edison type be used; for 60 volt service, 32 cells lead type or 50 cells Edison type be used; and for 110 volt service, 56 cells lead type or 92 cells Edison type be used.

3. It is recommended that generators be rated in watts, with the understanding that a supplemental rating in amperes or lamps of a specified wattage may be published.

4. It is recommended that for class (a) plant as outlined in paragraph 1, the standard adopted by The Electric Power Club [Rule 6631] be followed. For class (b) and (c) plant, it is recommended that for 32 volt service, generator ratings be based on 36 volts at full load, and temperature rise for continuous operation at 36 volt, and full load amperes shall not exceed 50° C. on windings and 65° C. on commutator. It is further recommended that shunt field windings be so proportioned that the temperature rise obtained on a 2 hour run at 42 volt, and one-half normal armature amperes immediately following the full load run will not exceed 50° C. For 60 volt service, generator ratings shall be based on 72 volt at full load for continuous operation, and 84 volt at one-half load for two hours following the full load run, and for

Reference
Number
(6696 *Continued*)

110 volt service, generator ratings shall be based on 125 volt at full load for continuous operation, and 145 volt at one-half load for two hours following the full load run. Temperature limits for 60 volt and 110 volt service shall be the same as stated for 32 volt service. All temperatures are to be measured by thermometers. [The normal rating is to be based on constant speed at rated load and a higher speed if necessary for the increased voltage and one-half normal armature amperes.]

5. It is understood that [load and temperature] tests shall be made and ratings based on generator as assembled in the complete unit with the battery disconnected and loaded with lamps or other resistances.

6. It is recommended that when the engine horse power rating is given it shall be the brake horse power at the stated speed available at the generator shaft. When the power pulley is provided, the horse power available at the pulley shall be given as the brake horse power at the rated speed when the generator is supplying no load.

(Recommended Practice 6-8-1921.)

GENERATORS — ALTERNATING CURRENT

(Exclusive of Turbo-Generators, Single Phase Alternators, Inductor Alternators, or Induction Generators.)

Reference Number

(6715) RATING STANDARDS.

(6716) Basis of Rating.

Alternating current generators shall be rated at the load that they are capable of carrying continuously without exceeding the temperature guarantees. The rating shall be expressed in kilovolt amperes available at the terminals at 0.8 power factor. Corresponding kilowatts should also be stated.

(Adopted Standard Revised 5-4-1916.)

It is recommended that the manufacturer's specification show the true kw. capacity of the machine in addition to other data.

(6717) Voltage Ratings.

Standard voltages shall be 240, 480, 600 and 2400 volts. (Recommended Practice 6-8-1914.)

(6718) Frequencies.

Standard frequencies shall be 25 and 60 cycles per second. (Adopted Standard 5-20-1912.)

(6724) Excitation Voltage.

Standard excitation voltage for field windings shall be 125-volts direct current.

(Adopted Standard 5-20-1912.)

(6730) PERFORMANCE SPECIFICATIONS.

(6731) Temperature Rise.

Temperature Rise in degrees centigrade when operating at normal rating and power factor and under other normal conditions as specified on the name plate.

Class of insulation	A
Load, per cent of normal	100%
Power factor	80—100%
Time rating	Continuous
Temperature rise—core and winding	50°

(Recommended Practice 5-4-1916.)

Temperature guarantees for overload not to be given.

For descriptive specification covering classes of insulation, see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

Temperature specifications are limited to altitudes not exceeding 3300 feet.

All temperature rises are based on an ambient temperature of 40° C. See Reference Number 5002 for restrictions in this connection.

For descriptive specifications covering temperature ratings see Reference Number 5303.

Reference Number

(6732) Overload.

Generators shall carry a momentary load of 150% of the normal ampere rating, the rheostat being set for rated load excitation.

(Adopted Standard 5-4-1916.)

(6733) Excitation for Guarantee.

The guarantees of operation given shall be met without excitation voltage exceeding standard. See Reference Number 6724.

(Recommended Practice 5-20-1912.)

(6740) Dielectric Test.

The dielectric test for alternating current generators shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1000 volts, excepting that field windings shall be tested with 10 times the exciter voltage, but in no case less than 1500 volts nor more than 3500 volts. (A. I. E. E. 2356 and 4361.)

(6747) Power Factor.

Standard general purpose alternators shall operate successfully at power factors at least as low as 0.8. (Adopted Standard 5-4-1916.)

(6748) Efficiency.

The efficiency of alternators shall correspond to the kilovolt amperes and power factor at which they are rated, and shall be the ratio of the energy output to the sum of the output and losses. The indeterminate losses may be assigned conventional values. The efficiency of 50° rated generators at all loads shall be corrected to a reference temperature of 75° C. (Adopted Standard 5-4-1916.)

(6749) General Guarantee.

See Reference Numbers 2001 to 2004, inclusive.

Reference Number

(6770) STANDARD MANUFACTURING PRACTICE.

(6773) Bores of Rotors.

Maximum and minimum bores for rotors of engine type generators shall be:

Rating Kv-a.	RPM	Min. Size Dia.	Max. Size Dia.
50	300	4½	6½
75	300	4½	6½
100	300	6	8
125	300	6½	8½
75	277	6	8
100	277	6	8
125	277	6½	8½
75	257	6	8
100	257	6½	8½
150	257	6½	8½
250	257	8	10
312	257	10	12
125	225	7	9
150	200	8	10
200	200	8½	11
250	200	8	13
312	200	10	12½

(Recommended Practice 6-8-1914.)

NOTE—The standardization of load and speed ratings is under consideration and is not covered by this rule.

(6775) Name Plate Marking.

The following minimum amount of information shall be given on all name plates:

(a) Manufacturer's type designation and frame number.

(b) Kv-a. output.

(c) Power factor.

(d) Time rating. (See Reference Number 5300.)

(e) Temperature rise—normal.

Reference
Number

(6775 *Continued*)

(f) Rated speed in R. P. M.
(g) Rated voltage.
(h) Rated current in amperes per terminal.
(i) Number of phases.
(j) Frequency in cycles per second.

NOTE—Item (a) shall be optional.

(Adopted Standard 6-10-1914.)

(6778) Direction of Rotation.

See Reference Number 5401.

(6790) STANDARD COMMERCIAL PRACTICE.

(6791) Charges for Special Bores.

See Reference Number 2006.

(6793) Charges for Pressing Rotor on Engine Shaft.

See Reference Number 2007.

MINING LOCOMOTIVES

Reference
Number

(7800) GENERAL CLASSIFICATIONS.

(7800-5) Types.

A mining locomotive is defined as an electric locomotive so designed and constructed as to be applicable for use either in mines or primarily for other industrial purposes (as distinguished from what is ordinarily known as a railway locomotive) and of the mining type. (Adopted Standard 5-2-1916.)

Trolley Type

(7810) RATING STANDARDS.

(7810-2) Basis of Motor Rating.

Mining locomotive motors shall be given Nominal Ratings which shall be the horse power output at the armature shaft, excluding gear and other transmission losses, which the motors will develop for one hou under normal rated conditions, on a stand test with covers removed and with natural ventilation, without exceeding the temperature rises guaranteed. See Reference Number 7815-2.

(Adopted Standard 5-2-1916.)

(7810-24) Voltage Ratings.

Standard voltages shall be 250 and 500 volts.

(Adopted Standard 5-2-1916,
Revised 5-7-1920.)

(7810-42) Locomotive Weights.

Standard sizes shall be:

a. For single-motor locomotives, 1, 2½, 3, 4, 5, 6, 8, and 10 tons.

b. For two-motor locomotives, 4, 6, 8, 10, 13, 15, 20 and 25 tons.

c. For three-motor locomotives, 15, 20, 25, 30, and 35 tons.

(Adopted Standard 5-2-1916,
Revised 5-7-1920.)

Reference
Number

(7815) PERFORMANCE SPECIFICATIONS.

(7815-2) Motor Temperature Rise.

Under normal rated load and the conditions of a stand test specified in Reference Number 7810-2, the temperature rises in degrees centigrade shall not exceed the following:

Commutator....................................90°
All other parts..................................75°

Temperature measurements by thermometer method, but in no case shall the resistance of any electrical circuit increase more than 40% during test.

Standard Ambient Temperature of Reference 25°C.

(Adopted Standard 5-2-1916.)

(7815-42) Draw Bar Pull.

The Draw Bar Pull on a straight and level track with dry, clean rails shall be determined as follows:

Running Draw Bar Pull, Steel Tread Wheels, 25% of weight of Locomotive.

Running Draw Bar Pull, Chilled Wheels, 20% of weight of Locomotive.

Starting Draw Bar Pull, (with sand), Steel Tread Wheels, 30% of weight of Locomotive.

Starting Draw Bar Pull (with sand), chilled Wheels, 25% of weight of Locomotive.

(Adopted Standard 5-2-1916,
Revised 5-7-1920.)

(7815-46) Basis of Guarantees.

Locomotive guarantee shall be based upon Draw Bar Pull in pounds on the level and speed in miles per hour that motors will develop as determined in accordance with Reference Number 7810-2, making allowance of 5% for each spur gear transmission, and 7½% for each bevel gear transmission, and 1% of the weight of the locomotive loss of tractive effort in journals, flanges and all other losses.

(Adopted Standard 5-2-1916.)

The word tansmission is understood to mean contact between any two gears.

Reference Number

(7820) STANDARD MANUFACTURING PRACTICE.

(7820-4) Trolley Poles.

The standard form of trolley pole for mining locomotives shall be the customary trailing wood pole wheel contact type.

(Adopted Standard 5-2-1916.)

(7820-42) Cut-off Switch.

A mining locomotive provided with more than one source of electrical supply, shall be provided, as standard equipment, with a switch of such character as to disconnect from the electric circuit of the locomotive, any current supply when it is not in use.

(Adopted Standard 5-2-1916.)

(7820-44) Headlight.

The standard headlight shall be an incandescent headlight provided with a silvered parabolic reflector and using a concentrated filament incandescent lamp.

(Adopted Standard 11-15-1916.)

(7820-84) Track Gauges.

In the interest of standardization of mining equipment, operators opening new mines are urged to adopt a track gauge of either 24 inches, 36 inches, or 42 inches, which shall be considered standard track gauges for mines.

(Recommended Practice 11-15-1916.)

(7820-88) Cab Construction.

The Cab shall be constructed of sheet steel and follow, in general, the outline now used on mining locomotives. (Recommended Practice 6-7-1921.)

(7825) STANDARD COMMERCIAL PRACTICE.

Storage Battery Type

Reference Number

(7830) RATING STANDARDS.

(7830-44) General Specifications

Chassis Weight	Draw Bar Pull Chilled Wheels	Speed Miles per Hour at 80 Volts	Motor Horsepower at 80 Volts
6,000#	1,000#	3½	11
7,000#	1,500#	3½	16
8,000#	2,000#	3½	22
10,000#	3,000#	3½	33

(Recommended Practice 11-17-1920.)

(7830-6) Storage Battery Rating.

Battery capacity on all sizes to be unlimited.

(Recommended Practice 6-7-1921.)

(7830-62) Battery Specifications.

The maximum size battery for the 6,000# chassis shall be:

48 cells of MV-19 Ironclad Exide Battery or,
48 cells of WML-23 Philadelphia Battery or,
88 cells of A-8 Edison Battery.

The maximum size battery for the 7,000# chassis shall be:

48 cells of MV-19 Ironclad Exide Battery or,
48 cells of WML-23 Philadelphia Battery or,
88 cells of A-8 Edison Battery.

The maximum size of battery for the 8,000# chassis shall be:

48 cells of MV-27 Ironclad Exide Battery or,
48 cells of WML-33 Philadelphia Battery or,
88 cells of A-12 Edison Battery.

There shall be no limitation as to the size of battery carried on the 10,000# chassis.

The kilowatt hour capacity of the battery shall be kept at or below the kilowatt hour capacity of

Reference
Number

(7830-62 *Continued*)

the maximum size battery specified for any particular make of battery, and for any size of chassis. The number of cells and number of plates is discretionary with the locomotive manufacturers within these limits.

(Recommended Practice 11-17-1920.)

(7835) PERFORMANCE SPECIFICATIONS.

(7835-2) Motor Temperature Rise.

Same as Reference Number 7815-2.

(7835-42) Draw Bar Pull.

Same as Reference Number 7815-42.

(7835-46) Basis of Guarantees.

Same as Reference Number 7815-46.

(7840) STANDARD MANUFACTURING PRACTICE.

(7840-44) Headlights.

Same as Reference Number 7820-44.

(7840-84) Track Gauges.

Same as Reference Number 7820-84.

(7840-88) Cab Construction.

Same as Reference Number 7820-88.

(7845) STANDARD COMMERCIAL PRACTICE.

(7845-2) Data Furnished by Manufacturer.

The specification sheet incorporated in the propositions for storage battery mining locomotives shall set forth the nominal weight of the chassis, the listed weight of the storage battery, and the approximate weight of the locomotive, the latter figure being equal to the sum of the two preceding figures.

(Adopted Standard 11-15-1916.)

INDUSTRIAL LOCOMOTIVES

Reference Number

(7850) GENERAL CLASSIFICATIONS.

Trolley or Third-Rail Types

(7860) RATING STANDARDS.

(7860-24) Voltage Ratings.

Same as Reference Number 7810-24.

(7860-42) Locomotive Weights.

Standard sizes shall be 15, 20, 25, 35, and 50 tons. The first two sizes are to be equipped with single trucks, the 25-ton size with either single or double trucks and the 35 and 50-ton sizes with double trucks only. (Recommended Practice 6-7-1921.)

(7860-44) General Specifications.

Weight	Truck	Horsepower	Approx. Speed
15 tons	Single	2 motors 75 H.P. each	7 M.P.H.
20 tons	Single	2 motors 75 H.P. each	7 M.P.H.
25 tons	Single	2 motors 90 H.P. each	7 M.P.H.
25 tons	Double	4 motors 40 H.P. each	7 M.P.H.
35 tons	Double	4 motors 75 H.P. each	7 M.P.H.
50 tons	Double	4 motors 90 H.P. each	7 M.P.H.

This table of figures is based on 20% of locomotive weight, steel tired wheels and a maximum adhesion of 25%.

(Recommended Practice 6-7-1921.)

(7865) PERFORMANCE SPECIFICATIONS.

(7865-2) Motor Temperature Rise.

Same as Reference Number 7815-2.

(7865-44) Normal Rated Speed.

Approximately 7 M.P.H.

(Recommended Practice 6-7-1921.)

(7870) STANDARD MANUFACTURING PRACTICE.

(7870-44) Headlight.

Same as Reference Number 7820-44.

Reference Number

(7870-46) Brakes.

One hand brake shall be standard on each locomotive. Automatic air brake with air valves to match control stations shall be standard on all locomotives except 15 and 20 ton sizes, where air brakes may be either straight or automatic.

(Recommended Practice 6-7-1921.)

(7870-48) Air Compressor Rating.

Locomotives of the 15, 20 and 25 ton sizes shall be equipped with air compressors which will operate at 25 lbs. pressure per square inch. Air compressors for the 35 ton size shall develop 35 lbs. pressure, and for the 50 ton locomotive 50 lbs. pressure. (Recommended Practice 6-7-1921.)

(7870-6) Control Equipment.

The drum type of controller shall be standard on single truck two-motor locomotives, and the drum, magnetic or electro-pneumatic type of controller shall be optional on double truck four-motor locomotives. One control station shall be standard in cabs of locomotives smaller than the 25 ton size, and two stations shall be used in cabs of locomotives of 25 tons and larger.

(Recommended Practice 6-7-1921.)

(7870-84) Track Gauge.

All track guages shall be not less than 36 in. nor more than 56½ in., except for the double truck 25 ton locomotive, which shall have a minimum gauge of 30 inches.

(Recommended Practice 6-7-1921.)

(7870-88) Cab Construction.

Same as Reference Number 7820-88.

(7875) STANDARD COMMERCIAL PRACTICE.

Storage Battery Type

Reference Number

(7880) RATING STANDARDS.

(7880-22) Nominal Motor Rating (Approximate).

10 Ton—Total H.P. 40 at nominal voltage of approximately 200.

15 Ton—Total H.P. 60 at nominal voltage of approximately 200.

25 Ton—Total H.P. 120 at nominal voltage of approximately 200.

40 Ton—Total H.P. 220 at nominal voltage of approximately 200.

(Recommended Practice 6-7-1921.)

(7880-42) Locomotive Weights and Deductions.

Nominal total weight to be the sum of the total chassis weight plus the average weight of the battery.

The nominal chassis weight to be independent of gauge, but to include complete electrical equipment, cab, air brake, standard M. C. B. couplers, and steel-tired wheels, but exclusive of battery.

Deductions from nominal chassis weight to be made on certain sizes for omission of cab, air brakes, and steel tires are as follows:

Allowable Deductions from Nominal Chassis Weight.

Nominal Total Weight	Nominal Chassis Weight	Cab	Air Brakes	Steel Tired Wheels	Type
10 Tons	8 Tons	2000	1200	800 lbs.	Single Truck
15 Tons	12½ Tons	2500	1500	1000 lbs.	Single Truck
25 Tons	20 Tons	None	None	None	Single or Double Truck
40 Tons	30 Tons	None	None	None	Double Truck

(Recommended Practice 6-7-1921.)

(7885) PERFORMANCE SPECIFICATIONS.

(7885-2) Motor Temperature Rise.

Same as Reference Number 7815-2.

Reference
Number

(7885-42) Nominal Rated Draw Bar Pull.

Eighteen per cent of nominal total weight of locomotive. (Compromise figure to establish approximate balance between different locomotive sizes, considering the possible mechanical performance and most desirable rated speed.)

(Recommended Practice 6-7-1921.)

(7885-44) Nominal Rated Speed.

Three and one-half to five miles per hour.

(Recommended Practice 6-7-1921.)

(7890) STANDARD MANUFACTURING PRACTICE.

(7890-42) Automatic Cut-off Switch.

All storage battery locomotives which are provided with trolley poles and are so built as to be capable of charging the battery from the trolley wire while traveling along shall, as standard equipment, be provided with an automatic protective device which will prevent the discharge of the battery into the trolley wire in the event of the trolley wire voltage dropping below the battery voltage.

(Adopted Standard 6-7-1921.)

(7890-44) Headlight.

Same as Reference Number 7820-44.

(7890-46) Brakes.

One hand brake only to be standard on all sizes.

Straight air brakes to be standard on the 10 ton size.

Straight or automatic air brake to be standard on the 15 ton size and above.

Brake control valves to match control stations on all sizes. (Recommended Practice 6-7-1921.)

Reference
Number

(7890-48) Air Compressor Rating.

Compressor capacity to be optional.
(Recommended Practice 6-7-1921.)

(7890-6) Control Equipment.

Drum control to be standard on single truck 2-motor locomotives, and drum, magnetic or electro-pneumatic control to be optional on double truck 4-motor locomotives. One control station to be standard in cabs of locomotives under 25 ton and two stations in cabs of locomotives 25 ton and above. (Recommended Practice 6-7-1921.)

(7890-84) Track Gauge.

All track gauges shall be not less than 36 inches nor more than 56½ inches.
(Recommended Practice 6-7-1921.)

(7890-88) Cab Construction.

Same as Reference Number 7820-88.

(7895) STANDARD COMMERCIAL PRACTICE.

ELECTRIC TOOLS
Buffers and Grinders

Reference Number

(7900) GENERAL CLASSIFICATIONS.

(7901) Types.

Buffing and grinding motors shall be divided into two classes:

(a) Grinding Motors.
(b) Buffing Motors.

Each class shall be divided into two groups:

(c) Bench Group.
(d) Floor Group. (Adopted Standard 11-9-1914.)

(7915) RATING STANDARDS.

(7917) Voltage Ratings.

1. Standard direct current voltages shall be 115 and 230 volts. (Adopted Standard 6-8-1914.)

2. Standard alternating current voltages shall be 110 and 220 volts. (Adopted Standard 6-8-1914.)

(7918) Frequencies.

Standard frequencies are 25 and 60 cycles per second. (Adopted Standard 6-8-1914.)

(7920) Speed Ratings—Grinding Motors.

Standard no load hot speed ratings for Grinding Motors shall be:

Diameter Wheel Inches	Motor Speed D. C. R.P.M.	Motor Speed 60 cyc. R.P.M.	Motor Speed 25 cyc. R.P.M.	Motor Speed 30 cyc. R.P.M.	Motor Speed 40 cyc. R.P.M.
4	4000	3600	....	....	....
5	3500	3600	....	....	....
6	3000	3600	....	....	2400*
7	2600	....	....	....	2400
8	2200	1800*	....	....	2400
10	1800	1800	1500	1800	2400
12	1500	1800	1500	1800	1200*
14	1300	1200	1500	900*	1200
16	1100	1200	1500	900*	1200
18	1000	1200	....	900	1200
20	900	1200	750*	900	1200
22	825	900	750	900	800
24	750	900	750	900	800

*Gives a surface speed on the wheel of less than 4,000 feet per minute. Under these conditions the wheel wears rapidly and cuts inefficiently. These combinations are to be avoided wherever possible.

The table given above applies to vitrified and silicate straight wheels and tapered wheels. It does not apply to cup and cylinder wheels or to wheels of elastic, vulcanite, and other organic bonds.

(Recommended Practice 11-10-1915.)

Reference Number

(7930) PERFORMANCE SPECIFICATIONS.

(7931) Temperature Rise.

Temperature Rise in degrees centigrade of all parts when operating under normal rated conditions as specified on the name plate.

Class of insulation	A
Load, per cent of rated	100
Time rating	Continuous
Grinding motors—enclosed type	55°

(Recommended Practice 5-4-1916.)

No overload temperature guarantee given.

For descriptive specification covering Class A insulation see Reference Number 5001.

All temperature measurements by thermometer method. See Reference Number 5301.

All temperature rises based on an ambient temperature of 40° C. See Reference Number 5002. General guarantees do not apply and deterioration on insulation may be expected if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see Reference Number 5303.

(7932) Overload.

Grinding motors shall carry a momentary load of 200% of the normal continuous rating.

(Adopted Standard 5-4-1916.)

(7970) STANDARD MANUFACTURING PRACTICE.

(7975) Name Plate Marking.

Name plates for grinding motors shall be marked:

a—Manufacturer's designation of types and frame sizes.
b—Horsepower output.
c—R. P. M. at no load.
d—Frequency, if alternating current.
e—Number of phases, if alternating current.
f—Voltage.
g—Rated load amperes.
*h—Basis of rating.
i—Serial number.
j—Winding (Shunt or Compound, if direct current).

(Adopted Standard 5-4-1916.)

*By "Basis of Rating" is meant that the nameplate must indicate that the rating is continuous. It is recognized, however, that the load of a grinding motor is extremely intermittent. It is therefore permissible to give, in addition, a short time rating, both rating and period to be shown.

NOTE—Item (a) shall be optional.

Diagram Markings

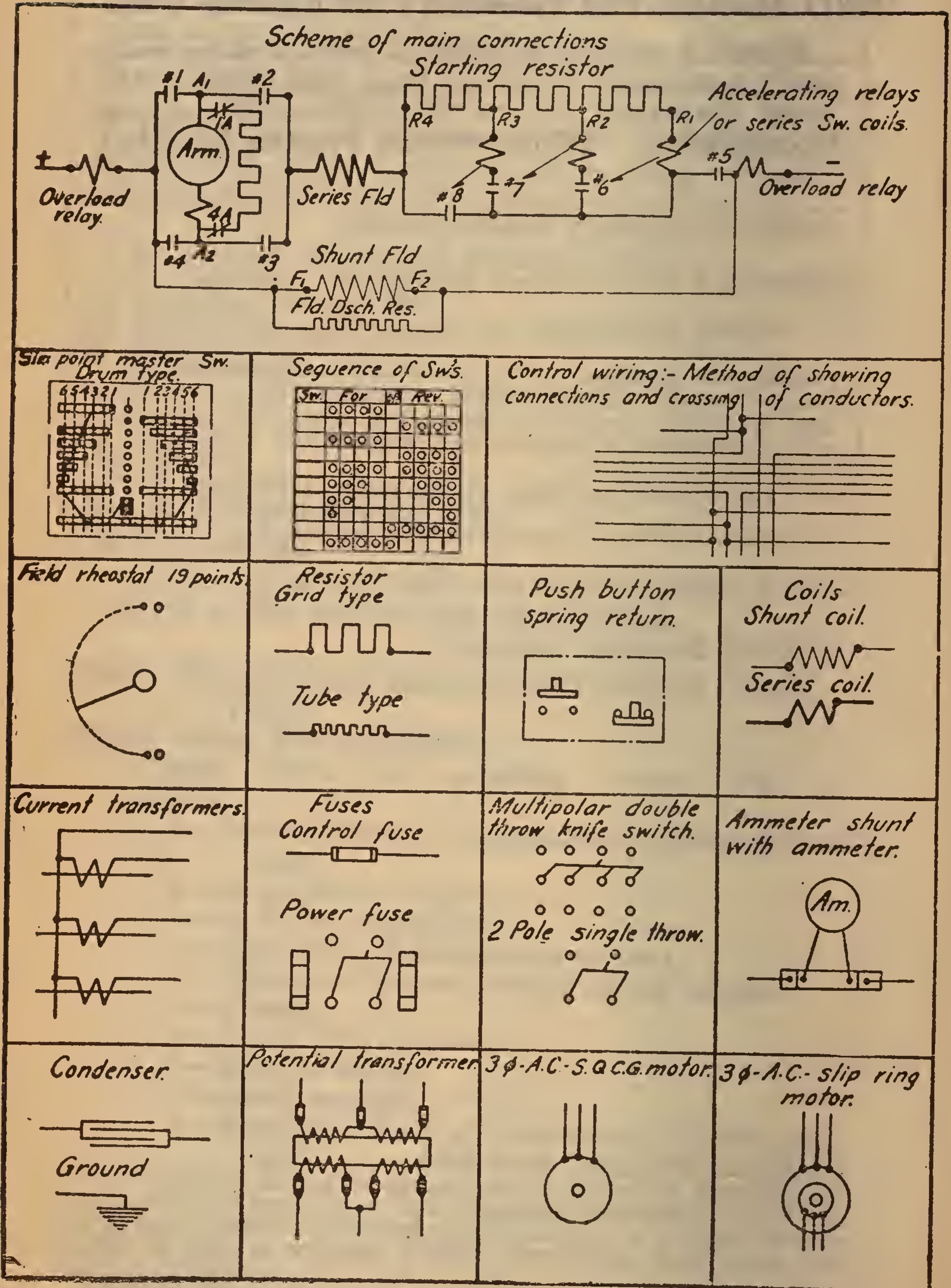
Reference Number

(8601) Marking End Connectors for Resistor Units.

Where a resistor is made of two or more units and it is necessary to connect these units together, the use of the letters "A" to "A", "B" to "B", etc., is recommended. (Recommended Practice 5-2-1916.)

Reference
Number
(8602) Symbols for Diagrams.

The following designating symbols shall be used on industrial control diagrams:



(Recommended Practice 6-11-1917.)

Control Equipment

Reference
Number

(8701) RATING STANDARDS.

(8702) Basis of Rating.

The rating of an industrial controller is based upon the class of service for which it can be used without exceeding the prescribed temperature limits. Overload capacity, where required, should be specified as an increased rating.

(Recommended Practice 5-23-1919.)

(8703) Service Classifications of Resistors.

The table on the following page gives numbers which are used to designate the resistors required for different classes of control service.

Reference Number

(8703 *Continued*)

Service Classification of Resistors by Numbers

Approximate per cent of full load current on the first point.	Light starting duty—15 sec. out of 4 min.	Heavy starting duty—30 sec. out of 4 min.	Light intermittent duty—one min. out of 4 min.	Heavy Intermittent duty—2 min. out of 4 min.	Continuous duty
25	#11	#31	#51	#71	#91
50	#12	#32	#52	#72	#92
70	#13	#33	#53	#73	#93
100	#14	#34	#54	#74	#94
150	#15	#35	#55	#75	#95
200 or over	#16	#36	#56	#76	#96

NOTE—15 Sec. out of 4 Min. means that the resistor will operate at its specified duty not more than a total of 15 seconds during any 4 minute period.

(Recommended Practice 6-11-1917.)

When testing resistors to meet the above classification, the test is to be continued for one hour.

(Recommended Practice 6-7-1921.)

(8703 *Continued*)

Starting and intermittent duty resistors in the classification table on the preceding page are primarily designed for use with motors requiring an initial torque corresponding to the current value for the class of resistor specified and requiring an average (root mean square) accelerating current not in excess of 125% of the full load value.

Where a test is made without the motor, the resistor shall be connected to a voltage that will give the initial inrush current specified, and the steps shall be cut out at equal intervals in the "time on" period of the cycle specified; the current during the cutting out period to be maintained at 125% of the rated value. This test to be repeated every four minutes for one hour.

(Recommended Practice 5-23-1919.)

(8704) Range of Operating Voltage for Contactors.

D.C. contactors to be able to withstand 10% increased voltage without injury to the operating coils and to close successfully at 20% less than normal voltage.

A.C. contactors to be able to withstand 10% increased voltage without injury to the operating coils and to close successfully at 15% less than normal voltage.

For successful operation at the minimum voltage for continuous duty, the contactor coil should be subjected to the normal line voltage until constant temperature is reached, and then tested for successful closing at the minimum voltage.

(Adopted Standard 5-30-1918.)

PERMISSIBLE TEMPERATURE RISE.

(8705) Temperature of Resistors.

The limiting observable temperature rise for resistors shall be 350 degrees C. when the thermometer can be placed against the resistive conductor, and 250 degrees C. when the thermometer is placed against the embedding material.

The limiting observable temperature rise for the issuing air shall be 175 degrees C. one inch from the enclosure.

NOTE—All temperature measurements to be by thermometer method.

(Adopted Standard 5-30-1918.)

Reference
Number

(8706) Temperature of Contactors.

1. **Operating Coils for Contactors:** The limiting observable temperature rise of operating coils for magnetic contactors shall be 70 degrees C. when measured by thermometer.

2. **Temperature of Contacts:** The limiting observable temperature rise for the contacts of magnetic contactors shall be the following:
65 degrees C. rise for laminated contacts.
75 degrees C. for solid contacts.

3. **Current-Carrying Parts Insulated with Asbestos or Other Fireproof Insulation:** The limiting observable temperature rise for current-carrying parts insulated with asbestos or other fireproof material shall be 150 degrees C.

NOTE—All temperature measurements to be by thermometer method.

(Adopted Standard 5-30-1918,
Modified 11-17-1920.)

(8707) Temperature of Bus-Bars.

The limiting observable temperature rise of bus-bars on controller panels shall be 50° C. when measured by thermometer.

(Recommended Practice 5-23-1919.)

(8708) Temperature of Coils and Methods of Measurement for Purposes of Design.

(Excepting Resistors, See Reference Number 8705.)

It is realized that the method of measuring the temperature of coils and other windings of control apparatus by placing a thermometer on the outside of the coil is at best an approximation only. The attached detail specifications have been prepared and are recommened for use in the designing of coil windings for controllers.

The Ambient Temperature of reference for air is 40° C.

The temperatures in the different parts of a device which it would be desirable to ascertain, are the maximum temperatures reached in those parts. In determining the temperatures, three methods are provided:

Reference Number

(8708 *Continued*) (Recommended Practice 11-17-1920.)

Method No. 1.—Thermometer Method.

This method consists in the determination of the temperature by mercury or alcohol thermometers, by resistance thermometers, or by thermo-couples, any of these instruments being applied to the hottest accessible parts of the completed device, as distinguished from the thermo-couples or resistance coils embedded in the device as described in Method No. 3.

The corrections as given in the following table shall be added to the highest temperature observed, *except* when the instruments are applied directly to the surface of bare windings when no correction is to be applied, to determine the maximum hottest spot temperature.

Method No. 2.—Resistance Method.

This method consists in the measurement of the temperature of windings by their increase in resistance. In the application of this method, thermometer measurements shall also be made whenever practicable without disassembling the device in order to increase the probability of revealing the highest observable temperature. Whichever measurement yields the higher temperature after adding the proper correction factor, that temperature shall be taken as the highest observable temperature, and a hottest spot correction as given in the following table is to be added thereto to give the maximum hottest spot temperature.

The following table is to be used for the temperature coefficient of Copper:

Temp. of the winding in degrees C. at which the initial resistance is measured.	Increase in resistance of copper per degree C., per ohm of initial resistance.
0	0.00427
5	0.00418
10	0.00409
15	0.00401
20	0.00393
25	0.00385
30	0.00378
35	0.00371
40	0.00364

Reference
Number

(8708 *Continued*) (Recommended Practice 11-17-1920.)

Method No. 3.—Embedded Temperature-Detector Method.

This method consists of the rise of thermocouples or resistance temperature detectors, located as nearly as possible at the estimated hottest spot. When these devices are used for such temperature determinations, a liberal number shall be employed, and all reasonable efforts, consistent with safety, shall be made to locate them at the various places where the highest temperatures are likely to occur. When this method is employed, no hottest spot correction is added to the highest observable temperature to determine the hottest-spot temperature.

The Ambient Temperature of reference for air shall be 40° C.

Temperature Limits for Insulating Materials.

Class Disc. of Material	Max. Hottest Spot Temp.	Hottest Spot Correction Method No. 1	Hottest Spot Correction Method No. 2	Limiting Observable Temp. Rise Method No. 1	Limiting Observable Temp. Rise Method No. 2
Class Disc. of Material				Example Winding 1" thick	
A* Cotton, silk, paper and similar materials, when so treated or impregnated as to increase the thermal limit, or when permanently immersed in oil; also enameled wire	130° C.	20° C. plus 1° C. for each 0.1" in thickness of the winding.	1° C. for each 0.1" in thickness of the winding.	60° C.	80° C.
B Mica, asbestos, and other materials capable of resisting high temperature in which any class A material or binder is used for structural purposes only, and may be destroyed without impairing the insulation or mechanical qualities of the insulation.	150° C.			80° C.	100° C
C Fireproof and refractory materials, such as pure mica, porcelain, quartz, etc.	No limits specified				

(*See next page for Note* *.)

Reference
Number

(8708 *Continued*)

*For cotton, silk, paper and similar materials, when neither treated, impregnated nor immersed in oil, the highest temperatures shall be 35° below the limits for class "A" in above table.

For shunt coils and whenever feasible, Method No. 2 must be used in determining temperatures.

Limiting observable Temperature Rise for:

*Bare enameled air insulated coils....90° C.

*This applies also to coils where a fibre sleeve or collar is used to insulate coil from frame or core.

The temperatures as given in preceding tables are the maximum temperatures observed in tests equivalent to operating conditions at the rated voltage, frequency and load for which the apparatus is rated.

(Recommended Practice 11-17-1920.)

(8800) STANDARD SPECIFICATIONS.

(8801) Overload Protection.

Overload protection above 5 H.P. 115 volts, or larger than 10 H.P., at the higher voltages, shall be provided by a contactor with overload relay or some sort of circuit breaker which shall respond to excessive current on one side of direct current and single phase alternating current circuits; and to excessive current in two sides of polyphase circuits. Fuses may be used for the protection of smaller motors.

(Recommended Practice 5-23-1919.)

(8802) Under or Low Voltage Release or Protection.

Where restarting of a motor on restoration of voltage may cause damage or injury, low voltage protection shall be furnished. For all other cases either low voltage release or low voltage protection shall be furnished.

(Recommended Practice 5-23-1919.)

Reference
Number

(8803) Inclosing Cases.

Standard inclosing cases shall be dustproof and splash-proof. (Recommended Practice 5-23-1919.)

(8804) Non-Corrodible Material.

Iron, steel, or other material with a suitable protective coating will be accepted as non-corrodible material. (Recommended Practice 5-23-1919.)

(8805) D. C. Manual Starting Rheostats for Voltages Above 600.

Standard starting rheostats must be able to open the circuit on the first point with the motor at rest.

Standard 500 volt face plate type D. C. manual starting rheostats may be furnished for a maximum of 600 volts. (Adopted Standard 11-17-1920.)

(8806) Inclosures for Controllers.

Inclosures are furnished with, and form a part of industrial control equipment for the purpose of affording protection by construction. These inclosures are of the following general classes:

Class I—A solid inclosure without slot or other opening.

Class II—A solid inclosure except for a slot for the operating handle or openings for ventilation, or both.

Class III—Wire mesh, perforated screens or grill work.

–01 All inclosures shall be so designed and assembled that they will withstand handling during shipment and installation.

–02 There must be sufficient space within inclosure to permit uninsulated parts of wire terminals to be separated so as to prevent their coming in contact with each other. Inclosures must be such as to permit proper wire connections to be made with adequate spacing of the terminals and ends of conductors from adjacent points of the inclosures.

Reference
Number

(8806 *Continued*) (Recommended Practice 6-7-1921.)

–03 Exposed non-arcing current-carrying parts within the inclosures must have an air space between them and the uninsulated part of the inclosure of at least ½″ for 600 volts or less. Inclosures of sizes, material or form not securing adequate rigidity must have greater spacing.

–04 All inclosures and part of inclosures such as doors, covers, tanks, etc., must be provided with means for firmly securing them in place. Among the available means are locks, interlocks, screws and seals.

–05 CLASS I AND II INCLOSURES.
Class I and II inclosures must afford protection against flashing or arcing.

–06 Where the walls of the inclosure are not protected by barriers or a lining of non-combustible insulating material the arc-rupturing parts of the controller shall have the following air spaces between them and the walls of the inclosure unless a test on any specific device demonstrates that a smaller space is safe for that particular device.

H. P. Rating	Distance from Contacts in Direction of Blowout		Vertical Distance above Contacts without Blowout				Horizontal Distance from Contacts and Distance below Contacts	
	D. C. and A. C.		D. C.		A. C.		D. C. and A. C.	
	300 V.	600 V.	300 V.	600 V.	300 V.	600 V.	300 V.	600 V.
5	1¾"	3"	4"	Barriers	1¾"	3"	¾"	1½"
10	2"	4"	5"	"	2"	4"	¾"	1½"
50	3"	5"	6"	"	3"	5"	1"	2"
100	4"	Barriers	Barriers	"	4"	Barriers	2"	3"
Above 100	Barriers	"	"	"	Barriers		Barriers	Barriers

NOTE—All distances to be measured from contact tips or arc horns.

Reference Number

(8806 *Continued*) (Recommended Practice 6-7-1920.)

–07 CONSTRUCTION:
Inclosures for industrial controllers may take the form either of cabinets, or of protective parts forming integral portions of the structure, or supplementary thereto, such as shields, covers, tanks, etc.

–071 For the purpose of these specifications a cabinet is considered as an inclosure, separable from and completely surrounding the control device as a whole, which is capable of being installed independently and is not necessary to the operation of the contained apparatus. It will usually have a door or doors for giving access to the apparatus.

–072 A cabinet may or may not be furnished by the maker of the control device.

–073 Protective parts are inclosures which are furnished by the manufacturer of the control device as integral parts of the structure or as supplementary thereto in the form of shields, covers, tanks, etc.

–074 Cabinets for control devices must comply with the requirements of Underwriters' Laboratories Standard for Cabinets and Cutout boxes.

–08 PROTECTIVE PARTS:

–081 MATERIAL. In the following it is assumed that steel (or gray iron for castings) will be the metal employed. Copper, bronze and brass are sometimes used, in which case the requirements given for steel shall be complied with.

–082 THICKNESS. Cast metal for protective parts whether of iron or other metal shall be at least ⅛ inch thick at every point and should be of greater thickness at tapped holes for conduit, at reinforcing ribs and door edges.

Reference
Number

(8806 *Continued*) (Recommended Practice 6-7-1920.)

–083 SHEET METAL THICKNESS. The minimum thickness required for sheet-metal construction varies with the size of the device.

–084 For Class I and II, protective parts of sheet metal shall be of a gauge not less than that given in the following table:

Maximum Volume of Inclosure Cubic Ft.	Maximum Area of Any Surface Sq. In.	Maximum Dimension Inches	Without Supporting Frame U. S. Sheet Steel Gauge	With Support-in Frame or Equivalent Re-enforcing U. S. Sheet Steel Gauge
¾		12	20 (.037)	24 (.025)
1		18	18 (.050)	20 (.037)
	360	24	16 (.062)	18 (.050)
	1200	48	14 (.078)	16 (.062)
	Over 1200		10 (.141)	16 (.062)

–09 All Class III inclosures shall be provided with a supporting frame.

–10 Wire screening used for inclosures must conform to the following:

Maximum Openings In Screen	Minimum Wire Size American Steel Wire Gauge
½″	No. 16
Over ½″ and not over 2″	No. 12

–11 Where the opening is over ½ inch the inclosure must not be less than four inches from any live part.

Reference
Number

(8806 *Continued*)

–12 Inclosures for floor-mounted controllers for voltages not in excess of 750 volts:

(a) Where the surrounding inclosure is six feet or more in height and exposed live parts are not less than six inches below the upper edge, no covering is required across the top of the inclosure.

EXCEPTIONS:—Where cranes or other movable apparatus or operations of a special character may introduce possible hazards from above, overhead inclosures may be required.

(b) Where the surrounding inclosure is within six inches of the floor and exposed live parts are not less than six inches above the lower edge, no covering will be required for the bottom.

(Recommended Practice 6-7-1921.)

(8810) Insulation Distances.

The distances between non-arcing, uninsulated live parts of control equipment to ground or to non-arcing uninsulated live parts of opposite polarity shall not be less than the following:

300 volts maximum, and in excess of 50 volts
¼″ through air or oil
⅜″ across clean dry surfaces in air or oil.

600 volts maximum
⅜″ through air or oil
½″ across clean dry surface in air or oil.

2500 volts maximum
1″ through air
¾″ through oil
2″ across clean dry surfaces in air
1″ across clean dry surfaces in oil

7000 volts maximum
2″ through air
1½″ through oil
3½″ across clean dry surfaces in air
2″ across clean dry surfaces in oil.

NOTE—These distances should be increased for dirty or moist conditions.

(Recommended Practice 6-7-1921.)

Reference Number

(8820) STANDARD RESISTORS FOR GENERAL PURPOSE MOTOR STARTERS.

(8821) Manual Starters for D. C. Motors.

(a) Resistor Classification.

50 H.P. and below—No. 14 or No. 15. Reference Number 8703.

Above 50 H.P.—No. 32, No. 33, No. 34 or No. 35. Reference Number 8703.

(Recommended Practice 5-23-1919.)

(8822) Automatic Starters for D. C. Motors.

(a) Resistor Classifications, No. 35 or No. 36, Reference Number 8703.

(Recommended Practice 5-23-1919.)

(8823) Manual Starters for Wound Secondary. Induction Motors.

(a) Resistor Classification.

50 H.P. and below—No. 14 or No. 15. Reference Number 8703.

Above 50 H.P.—No. 32, No. 33, No. 34 or No. 35. Reference Number 8703.

(Recommended Practice 5-23-1919.)

(8824) Automatic Starters for Wound Secondary Induction Motors.

(a) Resistor Classification—No. 35 or No. 36. Reference Number 8703.

(Recommended Practice 5-23-1919.)

(8830) SPECIFICATIONS FOR D. C. CONTACTOR TYPE CONTROLLER FOR GENERAL PURPOSE TRAVELNG CRANES.

(8830-1) General.

The control equipment shall conform to the standard rules of The Electric Power Club and the American Institute of Electrical Engineers.

The requisite contactors shall be provided for the basic functions of the controller, such as stopping, reversing, and for the specified number and character of speed control points.

The control equipment shall consist of the necessary master switches, contactor panels, resistors, and protective devices to meet the following requirements: (Recommended Practice 11-17-1920.)

Reference
Number

(8830-2) Resistor Mounting.

The resistor units shall be mounted in substantial end frames, and provided with terminals for connection to the control panel. Where the resistors are furnished for separate mounting, the wiring thereto is not to be included.

(Recommended Practice 11-17-1920.)

(8830-3) Master Switch.

The master switch shall be of the enclosed type and shall have renewable contacts and terminals for external connections.

The master switch for hoist control shall provide for not less than four points of speed control in each direction of operation for 25 H.P. motors or smaller, and not less than five points of speed control in each direction of operation for motors larger than 25 H.P.

The master switch for bridge and trolley travel controllers shall provide for not less than three points of speed control in each direction of operation except under any of the following conditions, where not less than four points shall be supplied:

(1) Where the full speed exceeds 150 feet per minute.

(2) Where cars are to be dragged along the floor.

(3) Where the rails are unusually slippery or uneven, and only one-half of the wheels are driven by motors.

(Recommended Practice 11-17-1920.)

(8830-4) Controller Functions.

The hoist controller shall provide for dynamic braking control in the lowering direction.

Low or under-voltage protection shall be provided for each motor, either as a function of each controller or by a protective panel.

Overload protection shall be provided for each motor, either as a function of each controller or by a protective panel. When it is on the protective panel, it shall include either two single pole or one double pole contactor, arranged for opening both sides of the line; and there shall be one overload relay in one side of the main line, and one overload relay for each motor circuit in the opposite side of the line.

Reference Number

(8830-5)

The continuous capacity of the main line contactors on the protective panel shall be not less than 50% of the combined one-half hour rating of the motors, nor less than 75% of the one-half rating of the largest individual motor.

(Recommended Practice 11-17-1920.)

(8830-6) Disconnecting Means.

A double pole line switch with provision for locking in the open position shall be provided, either on each controller or on the protective panel. When mounted on the protective panel, it shall have a carrying capacity not less than that specified above for the main line contactors.

(Recommended Practice 11-17-1920.)

(8830-7) Fuses in Control Circuit.

The control circuit system shall be protected by at least one fuse in each side of the line.

(Recommended Practice 11-17-1920.)

(8830-71) Additional Protective Panel Requirements.

Where a protective panel is provided as part of the control equipment of the crane there shall be provided:

(a) Two lamp receptacles on the protective panel fused and connected to the line wires outside of the line switch. These receptacles shall be connected in series; and, where necessary, a resistor shall be provided in this circuit so that 50 watt 115 volt lamps may be used.

NOTE—Two lamps may be used in these receptacles, or one lamp and one plug for a lamp cord, so that a working light may be had, with the line switch open.

(b) A safety and reset station shall be provided for opening and closing the line contactors of the protective panel.

(Recommended Practice 11-17-1920.)

Reference
Number

(8830-8) Magnet Brakes.

A magnet brake shall be furnished for the hoist motor of sufficient size to hold at least the rated full load torque of the motor when the magnet coil is disconnected.

(Recommended Practice 11-17-1920.)

(8830-9) Hoist Limit Switch.

Where a hoist limit switch is required on the crane, it shall be arranged to stop the motor before the hoist reaches its upper limit of travel, irrespective of a failure of voltage or position of the controller. The limit switch may be connected in the motor circuit directly, or a limit switch in the control circuit may be used, in which case an extra trolley wire will be provided by the customer for the control circuit.

NOTE—It is preferable to have the limit switch connected directly in the motor circuit and operated by the block.

(Recommended Practice 11-17-1920.)

TRANSFORMERS — DISTRIBUTION

Rules Applicable Only to Distribution Transformers for Lighting and Power Service

(Do not include those for special service, e.g., transformers for synchronous converters, instrument transformers, etc.)

Reference
Number

(9001) Classification.

1. Distribution transformers shall include primarily those transformers in sizes 200 KVA and below which are used to step down from a distribution voltage to a standard service voltage, and shall also include transformers in sizes 200 KVA and below used to step down from a transmission voltage to a distribution voltage.

(Adopted Standard 11-11-1917.)

(9015) Rating Standards.

1. Tables Nos. I and II respectively (see pages 203-4), summarize the standard types, frequencies, KVA sizes, voltage ratings and taps for single and three-phase distribution transformers for supplying lighting and power service.

(Adopted Standard 1-13-1919,
Amended 11-15-1921.)

(9016) Basis of Rating.

1. In the case of standard transformers having single voltage rating and provided with taps, the maximum rated voltage shall always be considered the normal voltage rating. In the case of standard transformers having a double or a triple voltage rating, the voltage appearing in bold type shall be considered the normal voltage rating. Performance guarantees of such transformers shall be based on the normal voltage rating and full winding. (Exception see Temperature Rise, Reference Number 9031, also Dielectric Tests, Reference Number 9040.)

(Adopted Standard 11-11-1917.)

Reference
Number

(9017) Voltage Ratings.

1. No definite standard transformer voltage ratings have yet been established for operation from standard system voltages of 88,000, 110,000, etc.
(Adopted Standard 11-11-1917,
Amended 11-15-1921.)

2. Multiple connection for 1150 volts shall be omitted from standard transformers of the 2300-volt class. (Adopted Standard 11-11-1917.)

3. Multiple connection of the high voltage winding shall be omitted in standard transformers of the 6900-volt class or for higher voltages since taps are provided in the high voltage winding of such transformers. (Adopted Standard 11-11-1917.)

4. Series multiple connections of more than one combination, or of ratios other than 2:1, such as 110/220/440, 460/2300, 440/550/2200, are particularly undesirable from the standpoint of best transformer design and construction.
(Adopted Standard 11-11-1917.)

(9023) Voltage Taps.

1. Standard transformers wound for voltages below the 6600-volt class shall not be provided with taps. (Adopted Standard 11-11-1917.)

2. Standard single phase transformers of the 6600 volt class or for higher voltages shall be provided with taps in the high voltage winding for approximately 5 and 10 per cent voltage variation. Exception to this rule is made only in the case of single phase transformers of the 6600 volt class for supplying service voltages 600 and below; present established practice necessitating the standardization of the following taps for such transformers:

(*Continued on page* 205)

Reference Number

(9015 *Continued from page 201.)*

SINGLE PHASE DISTRIBUTION TRANSFORMERS
SIZES 200 KV-A. AND BELOW
FOR SUPPLYING LIGHTING AND POWER SERVICE
STANDARD TYPES, FREQUENCIES, SIZES AND VOLTAGE RATINGS

STANDARD TYPES—Oil Immersed—Self Cooled

STANDARD FREQUENCIES—25 Cycles per Second—60 Cycles per Second

STANDARD SIZES IN KV-A. CONTINUOUS RATINGS AT 55 DEG. C. RISE

1.5-2.5-3-5-7.5-10-15-25-37.5-50-75-100-150-200

See Table below for sizes that are standard for the various system voltages.

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF TRANSFORMERS FOR THE VARIOUS SYSTEM VOLTAGES

Standard System Voltages	Standard Sizes for Each Voltage Class	For Supplying Service Voltages 600 and Below: Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately on Taps			Transformer Low Voltage Ratings for Supplying Service Voltages 600 and Below			For Supplying Distribution Voltages Above 600: Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately On 5% Tap	Approximately On 10% Tap	Transformer Low Voltage Ratings for Supplying Nominal 2300- or 4000-volt Distribution
440	1.5–3 to 100 incl.	440 **460** 480				...to 110/220 ...to **115/230** ...to 120/240						
550	1.5–3 to 100 incl.	550 **575** 600				...to 110/220 ...to **115/230** ...to 120/240						
2300	1.5–3 to 200 incl.	2200 **2300** 2400				...to 110/220 ...to **115/230** ...to 120/240	...or to 220/440 ...or to **230/460** ...or to 240/480	...or to 550 ...or to **575** ...or to 600				
4600	1.5–3 to 200 incl.	2200/4400 **2300/4600** 2400/4800				...to 110/220 ...to **115/230** ...to 120/240						
6600	1.5–3 to 200 incl.	6600/11430Y **6900/11950Y** 7200/12470Y	6300 6585 6875	6000 6275 6545	5700 5960 6220 (see Note)	...to 110/220 ...to **115/230** ...to 120/240	...or to 220/440 ...or to **230/460** ...or to 240/480	...or to 550 ...or to **575** ...or to 600	**6600/11430Y**	6270	5940	............to **2300** (See Note)
11000	2.5–5–10 to 200 incl.	11000 **11500**	10450 10925	9900 10350		...to 110/220 ...to **115/230**	...or to 220/440 ...or to **230/460**	...or to 550 ...or to **575**	**11000**	10450	9900	............to **2300/4000Y**
13200	2.5–5–10 to 200 incl.	13200 **13800**	12540 13110	11880 12420		...to 110/220 ...to **115/230**	...or to 220/440 ...or to **230/460**	...or to 550 ...or to **575**	**13200**	12540	11880	............to **2300/4000Y**
22000	5–10 to 200 incl.	22000 **23000**	20900 21850	19800 20700		...to 110/220 ...to **115/230**	...or to 220/440 ...or to **230/460**	...or to 550 ...or to **575**	**22000**	20900	19800	............to **2300/4000Y**
33000	10 to 200 incl.	33000 **34500**	31350 32775	29700 31050		...to 110/220 ...to **115/230**	...or to 220/440 ...or to **230/460**	...or to 550 ...or to **575**	**33000**	31350	29700	............to **2300/4000Y**
44000	15 to 200 incl.								**44000**	41800	39600	............to **2300/4000Y**
66000	50 to 200 incl.								**66000**	62700	59400	............to **2300/4000Y**

NOTE 1.—Transformers having low voltage rating of 115/230 for sizes 100 kv-a. and below are arranged for series, multiple or three-wire service by connection of the low voltage leads outside of the transformer tank; whereas, sizes 150 and 200 kv-a. are suitable for series or three-wire service only. Transformers having low voltage rating of 230/460 for sizes 200 kv-a. and below, are suitable for series or multiple service only.

These odd taps for distribution transformers of the 6600-volt class are chosen because of present established practice.

NOTE 2.—Standard Single-phase Distribution Transformers for supplying nominal 2300- or 4000-volt distribution and having voltage ratings listed above, will be designed for successful operation when excited on full winding at 5% above their rated voltage.

Transformers having voltage ratings of 6600/11430Y to 2300, are when operated in bank, suitable for transforming from 6600 to 2300; from 6600 to 4000Y or from 11430Y to 2300. They should not be used connected in "Y" on both high and low voltage sides simultaneously to transform from 11430Y to 4000Y as this connection may result in excessive stress in the windings due to harmonic voltages.

NOTE 3.—Voltage ratings in bold type will be considered the normal voltage ratings of these lines. For the basis of rating and performance guarantees, see Reference Number 9016. It is understood, however, that where a transformer is suitable for operation at two voltage ratings or at three voltage ratings, this flexibility will be definitely indicated on the name plate, on the connection diagram or on a paster inside the transformer cover.

NOTE 4.—See page 215 for Standard Accessories.

(Adopted Standard 5-5-1920, Effective 1-1-1921, Amended 11-15-1921, Effective 1-1-1922.)

TABLE I.

Reference Number

(9015 *Continued from page* 201)

THREE PHASE DISTRIBUTION TRANSFORMERS
SIZES 200 KV-A. AND BELOW
FOR SUPPLYING LIGHTING AND POWER SERVICE
STANDARD TYPES, FREQUENCIES, SIZES AND VOLTAGE RATINGS
STANDARD TYPES—Oil Immersed—Self Cooled
STANDARD FREQUENCIES—25 Cycles per Second—60 Cycles per Second
STANDARD SIZES IN KV-A. CONTINUOUS RATINGS AT 55 DEG. C. RISE
5—7.5—10—15—25—37.5—50—75—100—150—200
See Table below for sizes that are standard for the various system voltages.

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF TRANSFORMERS FOR THE VARIOUS SYSTEM VOLTAGES

Standard System Voltages	Standard Sizes for Each Voltage Class	For Supplying Service Voltages 600 and Below: Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately on 10% Tap	Transformer Low Voltage Ratings for Supplying Service Voltages 600 and Below	For Supplying Distribution Voltage Above 600: Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately On 5% Tap	Approximately On 10% Tap	Transformer Low Voltage Ratings for Supplying Nominal 2300-Volt Distribution
2300	5 to 200 incl.	2200/3810Y **2300/4000Y** 2400/4150Y		........to 220/440 ....to **230/460** ....to 240/480				
4600	5 to 200 incl.	4400Y **4600Y** 4800Y		........to 220/440 ....to **230/460** ....to 240/480				
6600	10 to 200 incl.	6600Y **6900Y** 7200Y	5940 6210 6480	........to 220/440 ....to **230/460** ....to 240/480	6600Y		5940	........to 2300
11000	10 to 200 incl.	11000Y **11500Y**	9900 10350	........to 220/440 ....to **230/460**	11000Y		9900	........to 2300
13200	10 to 200 incl.	13200Y **13800Y**	11880 12420	........to 220/440 ....to **230/460**	13200Y		11880	........to 2300
22000	15 to 200 incl.	22000Y **23000Y**	19800 20700	........to 220/440 ....to **230/460**	22000		19800	........to 2300
33000	37.5 to 200 incl.	33000Y **34500Y**	29700 31050	........to 220/440 ....to **230/460**	33000Y		29700	........to 2300
44000	50 to 200 incl.				44000Y	41800	39600	........to 2300
66000	150 to 200 incl.				66000Y	62700	59400	........to 2300

NOTES.—1.—All sizes of distribution transformers having low voltage ratings of 230/460 are suitable for series or multiple three-phase service only by proper connection inside of the tank.

2.—Voltage ratings in bold type will be considered the normal voltage ratings of these lines. For the basis of rating and performance guarantees, see Reference Number 9016. It is understood, however, that where a transformer is suitable for operation at two voltage ratings or at three voltage ratings, this flexibility will be definitely indicated on the name plate, on the connection diagram or on a paster inside the transformer cover.

3.—In general standard three-phase distribution transformers are not suitable for multiple operation with a bank of standard single-phase distribution transformers as the angular displacement, turn ratio and impedance volts on which successful multiple operation depends are generally different on three-phase and single-phase transformers.

4.—See page 215 for Standard Accessories.

(Adopted Standard 5-5-1920, Effective 1-1-1921, Amended 11-15-1921, Effective 1-1-1922.)

TABLE II

Reference
Number

(9023 *Continued from page* 202.)

6300/6600/5700 based on 6600 volts to 110/220, or to 220/440, or to 550-volt operation.

6585/6275/5960 based on 6900 volts to 115/230, or to 230/460, or to 575-volt operation.

6875/6545/6220 based on 7200 volts to 120/240, or to 240/480, or to 600-volt operation.

(Adopted Standard 1-13-1919,
Amended 11-15-1921.)

3. (a) Standard three phase transformers of the 6600 to 33000 volt classes inclusive, shall be provided with taps in the high voltage winding for approximately 10 per cent voltage variation.

(b) Standard three phase transformers of the 44000 and 66000 volt classes shall be provided with taps in the high voltage winding for approximately 5 and 10 per cent voltage variation.

(Adopted Standard 1-11-1917,
Amended 11-15-1921.)

4. The low voltage windings of distribution transformers of standard voltage ratings for supplying service voltage 600 and below, shall not be provided with taps.

(Adopted Standard 11-11-1917.)

(9030) PERFORMANCE SPECIFICATIONS.

Reference
Number

(9031) Temperature Rise.

1. The standard temperature rise at continuous rated KVA output shall not exceed 55° C. This temperature limit shall not be exceeded irrespective of whether the transformer is excited on full winding or, for transformers with which taps are standard, on any tap of 10% or less range; provided that for transformers having a single voltage rating the rated secondary voltage is delivered at the transformer terminals, and that for transformers with double or triple voltage ratings the temperature limit shall not be exceeded irrespective of whether the voltage delivered at the transformer terminals is the maximum or the minimum secondary voltage rating. (Adopted Standard 11-11-1917, Amended 11-15-1921.)

2. Temperature rise of transformer windings shall be determined by the resistance method (A. I. E. E., Section 6320).
(Adopted Standard 11-11-1917.)

3. Method of loading—(A. I. E. E., Section 6317). (Adopted Standard 11-11-1917.)

4. Temperature Co-Efficient of Copper—(A. I. E. E., Section 2321). (Adopted Standard 11-11-1917.)

5. Temperature of Oil—(A. I. E. E., Section 1007). (Adopted Standard 11-11-1917.)

6. When the elapsed time between the instant of shutdown and the time of final temperature measurement does not exceed three minutes, a correction of one degree per minute shall be added to the observed temperature rise.
(Adopted Standard 11-11-1917.)

NOTE.—All A. I. E. E. numbers corrected 11-15-1921.)

(9035) Voltage Regulation.

1. The guarantee as to regulation shall be based on a reference temperature of 75° C.
(Adopted Standard 11-11-1917.)

Reference
Number

(9035 *Continued*)

2. The test as to the fulfillment of the regulation guarantee shall be made at any convenient temperature and corrected to a reference temperature of 75° C. (Adopted Standard 11-11-1917.)

3. Tests and computation of regulation for constant potential transformers for any specified load and power factor shall be computed from the measured impedance watts and impedance volts, as follows:

Let: P=Impedance watts, as measured in the short circuit test (See Ref. 9048).

E_z=Impedence volts, as measured in the short circuit test (See Ref. 9048.)

IX=Reactance drop in volts.

I=Rated primary current.

E=Rated primary voltage.

q_x=Per cent drop in quadrature with current.

q_r=Per cent drop in phase with current.

m=Power factor of inductive load.

n=Reactive factor of inductive load.

NOTE—m and n are respectively the cosine and sine of the angle between current and voltage. For convenience the following table is given of corresponding values of m and n:

m	n	m	n
1.00	.00	.80	.60
.95	.31	.75	.66
.90	.43	.70	.71
.85	.55	.65	.76

Reference
Number

(9035 *Continued*)

Then A. For unity power factor we have approximately:

$$\text{Per cent regulation} = q_r + \frac{q_x^2}{200}$$

$$q_r = 100\frac{P}{EI}$$

$$q_x = 100\frac{IX}{E}$$

$$IX = \sqrt{E_z^2 - \left(\frac{P}{I}\right)^2}$$

B. For inductive loads of power factor *m* and reactive factor *n*:

$$\text{Per cent regulation} = mq_r + nq_x + \frac{(mq_x - nq_r)_2}{200}$$

(Adopted Standard 11-11-1917,
Corrected 11-15-1921.)

(9040) Dielectric Tests.

1. The standard values for insulation test voltages on distribution transformers other than small air-cooled transformers shall be as follows:

High Voltage Winding to Low Voltage Winding and Core.

Highest Operating Voltage.	Test Voltage.
Below 550 volts	4,000 volts
550 to 4,500 volts, inclusive	10,000 volts
Above 4500 to 50000 volts, incl.	Twice the highest rated voltage of the high voltage winding plus 1000 volts.

(*Continued on next page.*)

Reference
Number

(9040 *Continued*)

Above 50000 volts..............	Twice the *normal voltage of the circuit to which the high voltage winding is connected plus 1000 volts.

Low Voltage Winding to Core.

Highest Operating Voltage.	Test Voltage
1,500 volts and below..................	4,000 volts
Above 1,500 to 4,500 volts, inclusive.	10,000 volts

Above 4500 to 50000 volts incl..	Twice the highest rated voltage of the low voltage winding plus 1000 volts.
Above 50000 volts..............	Twice the *normal voltage of the circuit to which the low voltage winding is connected plus 1000 volts.

*In systems or circuits employing transformers, the Normal Voltage of the System or Circuit is defined as the highest rated voltage of the secondaries of transformers supplying the system or circuit. This voltage rating applies to all parts of that particular system or circuit.

(Adopted Standard 1-13-1919,
Amended 11-15-1921, effective 1-1-1922.)

Reference
Number

(9040 *Continued*)

2. Transformers intended for Y connection shall have their test voltages determined by the line voltage and not the leg voltage. For example: Distribution transformers of the 6600-volt class shall be given a test from high voltage winding to low voltage winding and core of 26,000 volts as it is common practice to connect these transformers in Y for operation at 12,470 volts.
(Adopted Standard 11-11-1917.)

3. Dielectric tests shall be made as outlined below:

a. Between high voltage and low voltage windings.

b. Between high voltage winding and the core. [(a) and (b) may be made at the same time by connecting the low voltage windings to the core.]

c. Between the low voltage winding and the core. (Adopted Standard 11-11-1917.)

4. The time of application for each test as outlined in preceding paragraphs of this section shall be one minute. (Adopted Standard 5-30-1918.)

5. Measurement of voltage in making dielectric tests shall be in accordance with A. I. E. E. Sections 2358 to 2370, inclusive.
(Adopted Standard 11-11-1917.)

6. Transformer oils shall be capable of withstanding, at commercial frequencies, 22,000 volts between 1″ disk-terminals spaced 1/10″ apart.
(Adopted Standard 6-7-1921.)

Reference
Number

(9048) **Losses and Efficiency.**

1. Guarantees as to losses shall be based upon a reference temperature of 75° C.

(Adopted Standard 11-11-1917.)

2. All losses shall be guaranteed on the basis of measure with a true sine wave.

(Adopted Standard 11-11-1917.)

3. If the wave form of the circuit employed for test differs from the sine wave. The deviation factor shall not exceed 10 per cent unless otherwise specified (A. I. E. E., Section 4351).

(Adopted Standard 11-11-1917,
Amended 11-15-1921.)

4. Transformer losses shall be considered under two divisions: No load losses and load losses. (A. I. E. E., Section 6335.)

(Adopted Standard 11-11-1917,
(Amended 11-15-1921.)

5. No load losses shall be the losses measured by wattmeter when normal rated voltage at rated frequency is applied to either winding, the other winding being open circuited. Since there is no appreciable variation of no load losses due to temperature changes, within the limits of operating temperatures, the test may be made at any convenient temperature without the necessity for correction by referring measured values to the standard reference temperature of 75° C. (A. I. E. E., Section 6336.)

(Adopted Standard 11-11-1917,
(Amended 11-15-1921.)

6. Load losses shall be the losses measured by wattmeter when adequate voltage is applied to primary winding to produce rated current in the secondary winding, the latter being short circuited. (Either the high voltage or the low voltage winding may be used as the primary.) Tests may be made

Reference
Number

(9048 *Continued*)

at any convenient temperature and corrected to the standard reference temperature of 75° C. (A. I. E. E., Section 6337).

(Adopted Standard 11-11-1917,
(Amended 11-15-1921.)

7. Tolerance Factors—

No load losses................10%
Load losses 5%

(Adopted Standard 11-11-1917.)

8. On orders covering three units or less, the above tolerances shall apply to each unit, but if an order covers more than three units, the tolerances shall apply to the individual units only. The obligation in the latter case shall be that the average losses of all the units on a particular order shall represent guaranteed values, and that no tolerance factors shall be applied to this average.

(Adopted Standard 11-11-1917.)

9. $$\text{Efficiency} = \frac{\text{KVA Output (100\% Power Factor)}}{\text{KVA Output (100\% Power Factor)} + \text{Total Losses at } 75^\circ \text{ C.}}$$

Total losses shall be obtained as outlined in preceding paragraphs of this Section.

(Adopted Standard 11-11-1917.)

10. All day efficiency, unless otherwise specified, shall be calculated on a basis of four hours full load and twenty hours no load.

(Adopted Standard 11-11-1917.)

(9070) STANDARD MANUFACTURING PRACTICE.

(9075) Nameplate Marking.

1. All transformer nameplates will include as a minimum the following information:

(a) Serial Number.
(b) Type.
(c) Number of phases.
(d) KVA and time rating.

Reference
Number

(9075 *Continued*)

(e) Voltage rating.
(f) Frequency.
(g) Temperature rise.
(h) Polarity (for single phase transformers).

(Adopted Standard 11-17-1920,
Effective 1-1-1921.)

2. All leads brought outside of the tank should be identified on the nameplate or on the connection diagram in accordance with Reference Number 9076 on Terminal Markings.

3. Plan view showing the relative location of external leads and internal terminals should be arranged to show the low voltage side at the bottom. With this arrangement the H1 high voltage lead will be located at the left and at the top of the sketch.

4. All internal terminals should be identified, preferably by the use of numerals. The sequence of numbering is not considered important.

5. Where development of windings is shown, saw tooth lines should be used—longer pitch and heavier lines being used to represent the low voltage winding.

6. The slant (/) should be used to separate voltages obtainable by use of taps or series multiple connection in the same winding.

The dash (—) should be used to separate voltage ratings of separate windings.

7. With polyphase transformers, voltage vector diagrams should be included to indicate the angular displacement.

(Paragraphs 2 to 7, Incl.,
Recommended Practice 6-7-1921.)

Reference
Number

(9076) Terminal Markings.

1. For method of marking transformer terminals see General Engineering Recommendations Reference Number 5406.

(Adopted Standard 5-30-1918.)

(9077) Polarity.

1. Subtractive Polarity shall be standard for all single phase transformers in sizes 200 KVA and smaller whose high voltage ratings are above 7500 volts.

Additive Polarity shall be standard for all single phase transformers in sizes 200 KVA and smaller, whose high voltage ratings are 7500 volts and below.

(Adopted Standard 6-7-1921,
Effective 1-1-1922.)

2. Single phase transformer nameplates shall in all cases contain the statement Subtractive Polarity or Additive Polarity to definitely indicate the polarity of the transformer to which the nameplate is attached. This statement will be in addition to the marking of the terminals in accordance with General Engineering Recommendations (Reference Number 5406), which marking also indicates polarity of the unit.

(Adopted Standard 11-17-1920,
Effective 1-1-1921.)

(9079) Transformer Accessories.

Standard accessories for single and three phase distribution transformers, sizes 200 KVA and smaller, will be in accordance with Table No. III (see page 215).

(Adopted Standard 11-17-1920,
Effective 1-1-1921.)

Reference Number

(9079 *Continued*)

STANDARD ACCESSORIES FOR SINGLE AND THREE PHASE DISTRIBUTION TRANSFORMERS OF STANDARDIZED RATINGS

(See pages 203-204 for Standard Ratings)

Voltage Class	STANDARD KV-A. SIZES IN THE VARIOUS VOLTAGE CLASSES WITH WHICH ACCESSORIES WILL BE REGULARLY FURNISHED															
	Plain Indicating Thermometer		Oil Gauge		Oil Drain Valve		Oil Drain Plug		Oil Sampling Valve		Provision for Filter Press Connection		Hanger Irons		Cutouts	
	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle
*440	No thermometers regularly furnished with 60-cycle transformers, sizes 200 kv-a. and smaller	150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller	10 and smaller	10 and smaller
*550		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller	15 and smaller	15 and smaller
2300		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller	50 and smaller	50 and smaller
4600		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller	No cutouts are regularly furnished with transformers in the 4600 and higher voltage classes	
6600		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller		
11000		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller		
13200		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller		
22000		150 and 200	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	37.5 and smaller	15 and smaller	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	No hanger irons are regularly furnished with transformers in the 22,000 and higher voltage classes			
33000		150 and 200	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	37.5 and smaller	15 and smaller	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.				
44000		150 and 200	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	37.5 and smaller	15 and smaller	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.				
66000		150 and 200	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	37.5 and smaller	15 and smaller	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.				

With a TRANSFORMER of SPECIAL RATING such accessories will be regularly furnished as would be supplied with a transformer of standard rating using the same mechanical parts.

***Transformers in the 440 and 550 voltage classes are standard for single phase units only.**

(Adopted Standard 5-5-1920, Effective 1-1-1921,
Modified 11-17-1920, Effective 1-1-1921.)

TABLE III.

Reference
Number

(9095) Three-to-Two, or Two-to-Three Phase Transformation.

Where two single phase transformers for three-to-two or two-to-three phase transformation are considered, the following practice is recommended:

(a) The KVA rating of each transformer should be one-half the bank output required, and the rating of the individual units should preferably agree with the standard sizes established for single phase transformers.

(b) Performance characteristics—except heating—should be based on single phase operation.

(c) Heating guarantees should be based on delivering the required bank capacity when transforming from three-to-two or two-to-three phase as specified.

(d) The standard practice should be the use of transformers interchangeable as main and teaser.

(e) It is not standard practice to equip transformers for three-to-two or two-to-three phase service with regulating taps.

(Recommended Practice 6-7-1921.)

TRANSFORMERS — POWER

Rules Applicable Only to Power Transformers for Lighting and Power Service

(Do not include those for special service, e.g., transformers for synchronous converters, electric furnaces, etc.)

Reference Number

(9201) Classification.

1. Power transformers shall be subdivided into "Generating Station Transformers" and "Substation Transformers." Generating station transformers shall include transformers in sizes above 200 KVA used as step up units in generating stations. Substation transformers shall include primarily those transformers in sizes above 200 KVA which are used to step down from a transmission voltage to a distribution voltage, and shall also include transformers in sizes above 200 KVA used to step down from either a transmission or distribution voltage to a standard service voltage.

(Adopted Standard 11-11-1917.)

(9215) Rating Standards.

1. Tables Nos. IV and V respectively (see pages 219-220) summarize the standard types, frequencies and KVA sizes for single and three phase power transformers; also the standard voltage ratings and taps for single and three phase substation transformers for supplying lighting and power service. (Adopted Standard 5-23-1919.)

(9216) Basis of Rating.

1. In the case of standard transformers having single voltage rating and provided with taps, the maximum rated voltage shall always be considered the normal voltage rating. In the case of standard transformers having a double voltage rating, the voltage appearing in bold type shall be considered the normal voltage rating. Performance guarantees of such transformers shall be based on the normal voltage rating and full winding. (Exception: See Reference Number 9231.)

(Adopted Standard 11-11-1917.)

Reference Number

(9216 *Continued*)

2. The rated capacity of a transformer shall be the continuous output in KVA that it will carry without exceeding a temperature rise of 55° C.
(Adopted Standard 11-11-1917.)

(9217) Voltage Ratings.

1. No definite standard power transformer voltage ratings have yet been established for operation from standard system voltages of 44,000, 66,000, 88,000, 110,000, etc.
Adopted Standard 11-11-1917.)

2. Multiple connections of the high voltage winding shall be omitted in standard transformers of the 6900-volt class or for higher voltages since taps are provided in the high voltage winding of such transformers. (Adopted Standard 11-11-1917.)

3. Series multiple connections of more than one combination, or of ratios other than 2:1, such as 110/220/440, 460/2300, 440/550/2200, are particularly undesirable from the standpoint of best transformer design and construction.
(Adopted Standard 11-11-1917.)

(9223) Voltage Taps.

1. Standard single phase substation transformers shall be provided with taps in the high voltage winding for 10% voltage variation in steps of approximately 2½%; and standard three phase substation transformers shall be provided with taps in the high voltage winding for 10% voltage variation in steps of approximately 5%.
(Adopted Standard 5-23-1919.)

2. Inasmuch as taps in three phase transformers multiply complications by three, as compared with single phase transformers, taps should be avoided where possible. (Adopted Standard 11-11-1917.)

Reference
Number
(9215 *Continued from page* 217)

SINGLE PHASE POWER TRANSFORMERS
SIZES ABOVE 200 KV-A.
FOR SUPPLYING LIGHTING AND POWER SERVICE
STANDARD TYPES, FREQUENCIES, SIZES AND VOLTAGE RATINGS

STANDARD TYPES

Oil Immersed—Self Cooled
Oil Immersed—Water Cooled
Air Blast

NOTE.—The application of Air Blast Transformers should be confined to systems where the voltage does not exceed 25,000

STANDARD SIZES IN KV-A. CONTINUOUS RATINGS AT 55 DEG. C. RISE

Oil Immersed—Self Cooled				Oil Immersed—Water Cooled or Air Blast			
250	667	1667	5000	500	1250	3333	10000
333	833	2000	6667	667	1667	5000	
400	1000	2500	8333	833	2000	6667	
500	1250	3333	10000	1000	2500	8333	

NOTE.—See following table for sizes that are standard for the various system voltages.

STANDARD FREQUENCIES

25 Cycles per Second
60 Cycles per Second

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF SUBSTATION TRANSFORMERS FOR THE VARIOUS SYSTEM VOLTAGES

Standard System Voltages	For Supplying Service Voltages 600 and below: Standard Sizes for Each Voltage Class — Oil Immersed Self Cooled	Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately on Taps 2½%	5%	7½%	10%	Transformer Low Voltage Ratings for Supplying Service Voltages 600 and Below	For Supplying Distribution Voltages Above 600: Standard Sizes for Each Voltage Class — Oil Immersed Self Cooled	Oil Immersed Water Cooled or Air Blast	Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately on Taps 2½%	5%	7½%	10%	Transformer Low Voltage Ratings for Supplying Nominal 2300 or 4000-volt Distribution
2300	250 to 500 incl.	2200 **2300**	2145 2245	2090 2185	2035 2130	1980 2070	...to 220/110 (3-wire) ...or to 220/440 or to 550 ...to **230/115** (3-wire) ...or to **230/460** or to **575**								
4600	250 to 500 incl.	2200/4400 **2300**/**4600**	4290 4485	2090/4180 2185/4370	4070 4255	1980/3960 2070/4140	...to 220/110 (3-wire) ...or to 220/440 or to 550 ...to **230/115** (3-wire) ...or to **230/460** or to **575**								
6600	250 to 500 incl.	6600 **6900**	6435 6730	6270 6555	6105 6385	5940 6210	...to 220/440 or to 550 ...to **230/460** or to **575**	250 to 1000 incl.	500 to 2500 incl.	**6600**	6435	6270	6105	5940	...to **2300/4000Y**
11000	250 to 500 incl.	11000 **11500**	10725 11215	10450 10925	10175 10640	9900 10350	...to 220/440 or to 550 ...to **230/460** or to **575**	250 to 2500 incl.	500 to 5000 incl.	**11000**	10725	10450	10175	9900	...to **2300/4000Y**
13200	250 to 500 incl.	13200 **13800**	12870 13455	12540 13110	12210 12765	11880 12420	...to 220/440 or to 550 ...to **230/460** or to **575**	250 to 2500 incl.	500 to 5000 incl.	**13200**	12870	12540	12210	11880	...to **2300/4000Y**
22000	250 to 500 incl.	22000 **23000**	21450 22425	20900 21850	20350 21275	19800 20700	...to 220/440 or to 550 ...to **230/460** or to **575**	250 to 2500 incl.	500 to 5000 incl.	**22000**	21450	20900	20350	19800	...to **2300/4000Y**
33000	250 to 500 incl.	33000 **34500**	32175 33640	31350 32775	30525 31915	29700 31050	...to 220/440 or to 550 ...to **230/460** or to **575**	250 to 2500 incl.	500 to 5000 incl.	**33000**	32175	31350	30525	29700	...to **2300/4000Y**

NOTE 1.—**Transformers having low voltage rating of 230/115 are** arranged for series or three-wire service only. **Transformers having low voltage rating of 230/460 are suitable for series or multiple service only.**

NOTE 2.—Standard Single-phase Substation Transformers for supplying nominal 2300 or 4000-volt distribution and having voltage ratings listed above, will be designed for successful operation when excited on full winding at 5% above their rated voltage.

NOTE 3.—Voltage ratings in bold face type will be considered the normal voltage ratings of these lines. For the basis of rating and performance guarantees, see Reference Number 9216. It is understood, however, that where a transformer is suitable for operation at two voltage ratings this flexibility will be definitely indicated on the name plate, on the connection diagram or on a paster inside the transformer cover.

(Adopted Standard 5-23-1919,
Corrected 11-15-1921.)

TABLE IV

Reference
Number

(9230) PERFORMANCE SPECIFICATIONS.

(9231) Temperature Rise.

1. The standard temperature rise at continuous rated KVA output shall not exceed 55° C. This temperature limit shall not be exceeded irrespective of whether the transformer is excited on full winding or, for transformers with which taps are standard, on any tap of 10% or less range; provided that for transformers having a single voltage rating the rated secondary voltage is delivered at the transformer terminals, and that for transformers with double voltage rating the temperature limit shall not be exceeded irrespective of whether the voltage delivered at the transformer terminals is the maximum or the minimum secondary voltage rating. (Adopted Standard 11-11-1917, Amended 11-15-1921.)

2. Temperature rise of transformer windings shall be determined by the resistance method (A. I. E. E., Section 6320).
(Adopted Standard 11-11-1917, Amended 11-15-1921.)

3. Method of Loading (A. I. E. E., Section 6317).
(Adopted Standard 11-11-1917, Amended 11-15-1921.)

4. Temperature Co-Efficient of Copper (A. I. E. E., Section 2321). (Adopted Standard 11-11-1917, Amended 11-15-1921.)

5. Temperature of Oil (A. I. E. E., Section 1007).
(Adopted Standard 11-11-1917, Amended 11-15-1921.)

6. The temperature rise of water cooled transformers shall be figured above the inlet water temperature. When the inlet water temperature varies appreciably from the air temperature, A. I. E. E. Section 6300 shall apply.
(Adopted Standard 11-11-1917, Amended 11-15-1921.)

Reference
Number
(9231 *Continued***)**

7. If at the time of making temperature test of an air blast transformer, the ambient temperature varies from 40° C., a correction factor as provided for in A. I. E. E. Section 6311 shall be applied.

(Adopted Standard 11-11-1917,
Amended 11-15-1921.)

8. In measuring transformer temperatures observed results shall include correction for falling temperature between the instant of shutdown and the instant of measurement (A. I. E. E. Section 6320).

For power transformers (sizes above 200 KVA) the following practice is accepted:

(a) *Oil Immersed Transformers*: For the purpose of simplifying the application of the rule to transformers when:

(1) The weight of copper in each winding is known:

(2) The copper loss as determined by wattmeter measurement does not exceed 30 watts per lb., the extrapolation method has been reduced to the following form and is recommended on account of the greater accuracy obtainable under ordinary conditions of testing. The correction in degrees C. shall be the product of the watts loss per lb. of copper for each winding multiplied by a factor depending upon the time elapsed between shutdown and the time of the temperature reading as given in the following table:

Time in Minutes.	Factor.
1	.19
2	.32
3	.43
4	.50

For intermediate times, the value of the factor can be obtained by interpolation.

Reference
Number

(9231 *Continued*)

Exception: When the copper loss, measured by wattmeter, does not exceed 7 watts per lb. an arbitrary correction of one degree per minute may be used provided the time elapsed between the instant of shutdown and the measurement of the hot resistance does not exceed 4 minutes.

For determining the copper loss in watts per lb. the total loss in both windings as measured by wattmeter should be apportioned between the high and low voltage windings in the same ratio as their respective I^2R losses.

(b) *Air Blast Transformers*: An arbitrary correction of one degree per minute may be used provided the time elapsed between the instant of shutdown and the measurement of the hot resistance does not exceed 4 minutes.

In measuring the temperature of air blast transformers, the air supply shall be shut off immediately at the end of the temperature run and the air intake closed to prevent further admission of cooling air. In checking the temperatures ascertained by the resistance method, the readings of thermometers well distributed and in good contact with the coils shall be noted and the maximum temperature indicated by them if higher than that determined by the resistance method, shall be taken as the maximum observable temperature of the windings. When the above procedure has been followed, a hottest spot correction of 5 degrees shall be applied.

(Adopted Standard 5-23-1919,
Amended 11-15-1921.)

(9235) Voltage Regulation.

1. The guarantee as to regulation shall be based on a reference temperature of 75° C.

(Adopted Standard 11-11-1917.)

2. The test as to the fulfillment of the regulation guarantee shall be made at any convenient temperature and corrected to a reference temperature of 75° C. (Adopted Standard 11-11-1917.)

3. Tests and computation of regulation for constant potential transformers for any specific load and power factor shall be computed from the measured impedance watts and impedance volts as follows:

Reference
Number

(9235 *Continued*)

Let: P=Impedance watts, as measured in the short circuit test.
(See Reference Number 9248.)

E_z=Impedance volts as measured in the short circuit test.
(See Reference Number 9248.)

IX=Reactance drop in volts.

I=Rated primary current.

E=Rated primary voltage.

q_x=Per cent drop in quadrature with current.

q_r=Per cent drop in phase with current.

m=Power factor of inductive load.

n=Reactive factor of inductive load.

Note: m and n are respectively the cosine and sine of the angle between current and voltage. For convenience the following table is given of corresponding values of m and n:

m	n	m	n
1.00	.00	.80	.60
.95	.31	.75	.66
.90	.43	.70	.71
.85	.55	.65	.76

Then A. For unity power factor we have approximately:

$$\text{Per cent regulation} = q_r + \frac{q_x^2}{200}$$

$$q_r = 100\frac{P}{EI}$$

$$q_x = 100\frac{IX}{E}$$

$$IX = \sqrt{E^2 - \left(\frac{P}{I}\right)^2}$$

Reference
Number

(9235 *Continued*)

B. For inductive loads of power factor *m* and reactive factor *n*:

$$\text{Per cent regulation} = mq_r + nq_x + \frac{(mq_x - nq_r)^2}{200}$$

(Adopted Standard 11-11-1917,
Amended 11-15-1921.)

(9240) Dielectric Tests.

1. The standard values for insulation test voltages for power transformers shall be as follows:

High Voltage Winding to Low Voltage Winding and Core.

Highest Operating Voltage.	Test Voltage.
Below 550 volts	4,000 volts
550 to 4,500 volts, inclusive	10,000 volts
Above 4500 to 50000 volts incl.	Twice the highest rated voltage of the high voltage winding plus 1000 volts.
Above 50000 volts	Twice the *normal voltage of the circuit to which the high voltage winding is connected plus 1000 volts.

*See note on next page.

Low Voltage Winding to Core.

Highest Operating Voltage.	Test Voltage.
1,500 volts and below	4,000 volts
Above 1,500 to 4,500 volts, inclusive	10,000 volts

Reference
Number

(9240 *Continued*)

Above 4500 to 50000 volts incl.	Twice the highest rated voltage of the low voltage winding plus 1000 volts.
Above 50000 volts	Twice the *normal voltage of the circuit to which the low voltage winding is connected plus 1000 volts.

*In systems or circuits employing transformers, the Normal Voltage of the System or Circuit is defined as the highest rated voltage of the secondaries of transformers supplying the system or circuit. This voltage rating applies to all parts of that particular system or circuit.

(Adopted Standard 1-13-1919.)
Amended 11-15-1921, effective 1-1-1922.)

2. Transformers intended for Y connection shall have their test voltages determined by the line voltage and not the leg voltage.

(Adopted Standard 11-11-1917.)

3. Dielectric tests shall be made as outlined below:

a. Between high voltage and low voltage windings.

b. Between high voltage winding and the core. [(a) and (b) may be made at the same time by connecting the low voltage winding to the core.]

c. Between the low voltage winding and the core. (Adopted Standard 11-11-1917.)

Reference
Number

(9240 *Continued*)

4. The time of application for each test as outlined in preceding paragraphs of this section, shall be one minute. (Adopted Standard 5-30-1918.)

5. Measurement of voltage in making dielectric tests shall be in accordance with A. I. E. E. Sections 2358 to 2370 inclusive.
(Adopted Standard 11-11-1917,
Amended 11-15-1921.)

6. Transformer oils shall be capable of withstanding, at commercial frequencies, 22,000 volts between 1" disk-terminals spaced 1/10" apart.
(Adopted Standard 6-7-1921.)

(9248) Losses and Efficiency.

1. Guarantees as to losses shall be based upon a reference temeprature of 75° C.
(Adopted Standard 11-11-1917.)

2. All losses shall be guaranteed on the basis of measurement with a true sine wave.
(Adopted Standard 11-11-1917.)

3. If the wave form of the circuit employed for test differs from the sine wave. The deviation factor shall not exceed 10% unless otherwise specified. (A. I. E. E., Section 4351.)
(Adopted Standard 11-11-1917,
Amended 11-15-1921.)

4. Transformer losses shall be considered under two divisions: No load losses and load losses. (A. I. E. E., Section 6335.)
(Adopted Standard 11-11-1917,
Amended 11-15-1921.)

5. No load losses shall be the losses measured by wattmeter when normal rated voltage at rated frequency is applied to either winding, the other winding being open circuited. Since there is no appreciable variation of no load losses due to temperature changes, within the limits of operating temperatures, the test may be made at any convenient temperature without the necessity for cor-

Reference
Number

(9248 *Continued*)

rection by referring measured values to the standard reference temperature of 75° C. (A. I. E. E. Section 6336.) (Adopted Standard 11-11-1917, Amended 11-15-1921.)

6. Load losses shall be the losses measured by wattmeter when adequate voltage is applied to the primary winding to produce rated current in the secondary winding, the latter being short circuited. (Either the high voltage or the low voltage winding may be used as the primary.) Tests may be made at any convenient temperature and corrected to the standard reference temperature of 75° C. (A. I. E. E., Section 6337.)

(Adopted Standard 11-11-1917, Amended 11-15-1921.)

(9248 *Continued*)

7. Tolerance Factors—

No load losses 10%
Load losses 5%

(Adopted Standard 11-11-1917.)

8. On orders covering three units or less, the above tolerances shall apply to each unit, but if an order covers more than three units, the tolerance shall apply to the individual units only. The obligation in the latter case shall be that the average losses of all the units on a particular order shall represent guaranteed values, and that no tolerance factors shall be applied to this average.

(Adopted Standard 11-11-1917.)

9. $\text{Efficiency} = \dfrac{\text{KVA Output (100\% Power Factor)}}{\text{KVA Output (100\% Power Factor)} + \text{Total Losses at } 75^\circ\text{ C.}}$

Total losses shall be obtained as outlined in preceding paragraphs of this section.

(Adopted Standard 11-11-1917.)

(9270) STANDARD MANUFACTURING PRACTICE.

Reference
Number

(9275) Nameplate Marking.

1. All transformer nameplates will include as a minimum the following information:

(a) Serial Number.
(b) Type.
(c) Number of phases.
(d) KVA and time rating.
(e) Voltage rating.
(f) Frequency.
(g) Temperature rise.
(h) Polarity (for single phase transformers).

(Paragraph 1 Adopted Standard 11-17-1920, Effective 1-1-1921.)

2. All leads brought outside of the tank should be identified on the nameplate or on the connection diagram in accordance with Reference Number 9276 on Terminal Markings.

3. Plan view showing the relative location of external leads and internal terminals should be arranged to show the low voltage side at the bottom. With this arrangement the H1 high voltage lead will be located at the left and at the top of the sketch.

4. All internal terminals should be identified, preferably by the use of numerals. The sequence of numbering is not considered important.

5. Where development of windings is shown, saw tooth lines should be used—longer pitch and heavier lines being used to represent the low voltage winding.

6. For transformers—except sizes 200 KVA and smaller—the Table of Connections should show the current capacity at the various regulating tap voltages.

7. The slant (/) should be used to separate voltages obtainable by use of taps or series multiple connection in the same winding.

The dash (—) should be used to separate voltage ratings of separate windings.

8. With polyphase transformers voltage vector diagrams should be included to indicate the angular displacement. (Paragraphs 2 to 8, Incl., Recommended Practice 6-7-1921.)

Reference
Number

(9276) Terminal Markings.

1. For method of marking transformer terminals see General Engineering Recommendations Reference Number 5406.

(Adopted Standard 5-30-1918.)

(9277) Transformer Polarity.

1. Subtractive Polarity shall be standard for all single phase transformers in sizes above 200 KVA, irrespective of voltage rating.

(Adopted Standard 5-5-1920,
Effective 1-1-1921.)

2. Single phase transformer nameplates shall in all cases contain the statement Subtractive Polarity or Additive Polarity to definitely indicate the polarity of the transformer to which the nameplate is attached. This statement will be in addition to the marking of the terminals in accordance with General Engineering Recommendations (Reference Number 5406) which marking also indicates polarity of the unit.

(Adopted Standard 11-17-1920,
Effective 1-1-1921.)

(9279) Transformer Accessories.

Standard accessories for single phase and three phase power transformers, sizes above 200 KVA, shall be as follows:

Oil guage, oil drain valve, oil sampling valve and provision for filter press connection, shall be regularly furnished with all single phase and three phase power transformers in sizes above 200 KVA.

Plain standard indicating thermometers shall be regularly furnished with all single phase and three phase power transformers in sizes above 200 KVA except that indicating thermometers with alarm contact will be furnished with self-cooled transformers 1000 KVA and larger, also with all water-cooled transformers irrespective of size.

(Adopted Standard 11-17-1920,
Effective 1-1-1921.)

Reference
Number

(9295) Transformation Three-to-Two, or Two-to-Three Phase.

Where two single phase transformers for three-to-two or two-to-three phase transformation are considered, the following practice is recommended:

(a) The KVA rating of each transformer should be one-half the bank output required, and the rating of the individual units should preferably agree with the standard sizes established for single phase transformers.

(b) Performance characteristics—except heating—should be based on single phase operation.

(c) Heating guarantees should be based on delivering the required bank capacity when transforming from three-to-two or two-to-three phase as specified.

(d) The standard practice should be the use of transformers interchangeable as main and teaser.

(e) It is not standard practice to equip transformers for three-to-two or two-to-three phase service with regulating taps.

(Recommended Practice 6-7-1921.)

Reference
Number

(10000) CLASSIFICATION.

(10001) Switchboard General Specification Form.

The following form representing the standard practice of manufacturers shall be submitted to the Purchaser with specifications in all proposals for Power Switchboards:

SWITCHBOARD—GENERAL SPECIFICATIONS.

The switchboard apparatus, herein described, will be supplied in accordance with information given in the

Switchboard Inquiry & Data Sheet
Information Form
specifications
and the Panel
Detail

dated..., which are attached hereto and made a part hereof. In order to prevent any misunderstanding as to the obligations of...Company, the following general specifications will apply to the apparatus covered by this proposal, except as elsewhere expressly modified by the Company's Panel
Detail
specifications attached.

THE COMPANY WILL FURNISH—in addition to the apparatus covered in the above mentioned Detail
Panel specifications the following apparatus:

(a) Panel supporting frame with mounting bolts and necessary fittings; steel channel base for switchboards having sub-panels; and fittings for attaching wall braces. (Pipe for wall braces to be furnished by purchaser.)

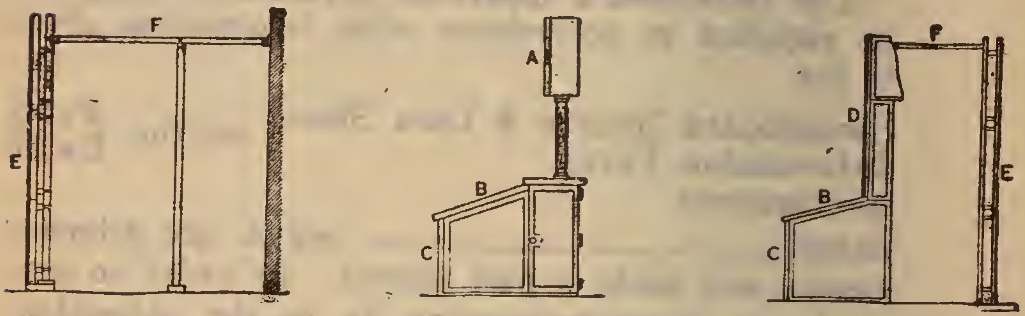
(b) Necessary resistors, reactors and other auxiliaries to make complete the instrument, meter and relay equipment furnished by the Company.

(c) One card holder for each circuit.

Reference
Number

(10001 *Continued*)

(d) Necessary material for small wiring for interconnecting instruments, meters, relays and other apparatus mounted on the panels or on a structure integral with the panel supporting frame. (For panels as indicated by E, Figures 1 and 2, this material will be assembled on the panels. For benchboard panels and structure integral with switchboard or benchboard panels as indicated by A, B, C, D, and F, Figures 1, 2 and 3, this material will be furnished in bulk unassembled.)



(e) Power and exciter busses on the switchboard or when mounted on a structure integral with the panel supporting frame; and connections between busses, switching devices, shunts, current transformers, etc., when mounted on the switchboard or on a structure integral with panel supporting frame. (When the switchboard is not completely assembled at the factory, this material will be furnished uncut—see clause under "Fabrication, Assembly and Erection.")

(f) Standard doors for the front of oil circuit breaker compartments, but no other doors unless specified; and the Company's standard cell hardware for circuit breakers (except, see "i").

(g) One set of fuses for such fuse holders as are specified for power circuits; two sets of fuses for such fuse holders as are specified for the primary potential transformer circuits; and two sets of fuses for required small fuse holders in the circuits to instruments, meters and relays.

(h) Oil for all apparatus requiring it.

Reference Number

(10001 *Continued*) (Adopted Standard 11-17-1920.)

THE PURCHASER WILL FURNISH—unless otherwise expressly agreed:

(i) Foundations, floors and walls, including all structural steel, bolts, nuts or inserts in or on them, concrete, brick or woodwork, floor or wall braces; and supports on or against which panels, compartments and busses will rest.

(j) Instrument and control wiring when not mounted on the switchboard or a structure integral with the panel supporting frame; cables to connect generators, exciters, transformers, etc., to the switchboard apparatus and lightning arresters to the main lines; conduit for instrument and control wiring and main cables; and supports for cables and conduit.

(k) All insulation and taping required for busses and their connections which must be installed after the erection of the apparatus.

(l) Metal connecting rods for remote controlled devices.

(m) All openings in walls or floors with coverings for same; and insulators and bushings in or on floors, walls, ceilings and concrete or brick structure.

(n) Material for barriers, shelves and partitions; and doors for bus bar or other compartments (except, see "f").

(o) Suitable drawings of the station buildings, showing the location of all openings in walls, all ducts and conduits, floor beams, etc., which have a bearing on the proper execution of the work under this agreement.

ADDITIONAL ITEMS—to be furnished by either party, as follows:

The Company will furnish items..............................

The Purchaser will furnish items.............................

Reference
Number

(10001 ***Continued*****)** (Adopted Standard 11-17-1920.)

(1) Power busses when not mounted on the switchboard or a structure integral with the panel supporting frame.

(2) Auxiliary frame work for circuit breakers, busses, etc. (When supplied by the Company, pipe for this frame work will be furnished unfabricated in commercial lengths, unpainted.)

(3) Connections between busses, switchnig devices, shunts, current transformers, disconnecting switches, etc., when not mounted on the switchboard or a structure integral with the panel supports. (When supplied by the Company this material will be furnished in commercial lengths, unfabricated, unless otherwise specified.)

posts
(4) Terminal boards in the rear of A. C. panels
blocks
for instrument and control wiring.

posts
(5) Testing blocks in the rear / front of A. C. panels.
boards

(6) ....

(7) ....

SWITCHBOARD ILLUMINATION. Switchboard illumination can be best obtained by general room illumination. Illuminating lamps mounted on switchboards are not recommended and no provision is made for them

WIRE, CABLE, BUS AND CONNECTION MATERIAL. The quantities of wire, cable, bus and connection material herein specified, and stated in pounds or feet, are estimated to be sufficient to meet the requirements and conditions known to the Company at the time of submitting this proposal. If more or less than the quantities stated are supplied due to a change in requirements or conditions, an extra charge will be made, or credit given.

Reference
Number

(10001 *Continued***)** (Adopted Standard 11-17-1920.)

MACHINE ACCESSORIES. Rheostats, field discharge resistors, starting resistors and auto transformer starters or starting compensators will not be furnished with the switchboard, unless expressly specified.

CHANGE IN APPARATUS. Should changes or additional information necessitate the alteration of, or the rebuilding of apparatus, already built, or partially built, or the furnishing of additional apparatus or material, the expense incidental thereto will be charged to the Purchaser, and the Purchaser agrees to pay such additional charge.

This proposal contemplates the furnishing of the Company's standard apparatus, except where noted in the detail specifications.

FABRICATION, ASSEMBLY AND ERECTION. Unless specified to the contrary, when the switchboard apparatus is to be mounted on the panels or on a frame work integral with the panel supports, switchboards will be assembled at the Company's Works to such an extent as may be necessary to insure accuracy of workmanship and design. Other apparatus not to be so mounted will not be assembled at the Works unless specifically mentioned in the attached detail specifications. When the apparatus is not assembled at the Works, the pipe for frame work and oil circuit breaker supports, wire, rods, tubes and bars for connections and busses will not be fabricated at the Works, but will be furnished in bulk, in commercial lengths, with the necessary fittings.

All iron and steel parts fabricated at the Works will be painted before shipment. Unfabricated parts will be furnished unpainted.

The Company reserves the right to disassemble such parts of switchboards as may be necessary for convenient and safe shipment.

The Purchaser will assemble and erect all switchboard parts on his premises, unless particular mention is made in detail specification that the Company will so assemble and erect.

Reference
Number

(10001 *Continued***)** (Adopted Standard 11-17-1920.)

TEMPERATURE. Switching devices covered by the attached specifications will carry continuously their rated current, and the rated currents of the circuits in which they are applied, without exceeding the temperature rise limits set by the A. I. E. E. Standardization Rules. These ratings are based on an ambient temperature of 40° C.

Maximum temperature of contacts in air when clean and bright, 70° C.

Maximum temperature of oil and contacts therein, 70° C.

Maximum temperature on coil insulation, according to insulation, 108° C. to 125° C. (except materials such as pure mica, porcelain, etc., no limits specified).

Maximum temperature of other parts, including frames, such temperature as shall not be injurious in any other respect.

Fuses, shunts for meters, and resistors which must necessarily operate at temperatures higher than the foregoing limits will be so placed that they will not increase the temperature of other apparatus above the limits stated.

Bare busses and bare conductors may be operated at temperatures not exceeding 90° C., providing their location or connection does not increase the temperature of connected switching devices above 70° C., or of connected insulated conductors above that specified in the A. I. E. E. standardization rules. Where insulated conductors are used, their temperature rise shall not exceed that specified by the A. I. E. E. standardization rules.

DESIGN. The attached Panel / Detail specifications are subject to minor modifications by the Company at the time of design to meet latest practice and most efficient arrangement of apparatus. If this proposal provides for the delivery of a switchboard to form a part of an existing installation, the Company will furnish an equipment to match, as near as may be

Reference
Number

(10001 ***Continued*****)** (Adopted Standard 11-17-1920.)

feasible, the present installation. The Company reserves the right, however, to substitute the latest improved devices in standard details on the switchboard in place of superseded designs which are not in stock.

RESPONSIBILITY. The Company will not be responsible for defects in devices not manufactured by the Company when such devices are specified by the customer, contrary to the recommendation of the Company.

Unless otherwise specified, the design of the Switchboard covered by this proposal will be such that it can be erected and installed to comply with the "National Electrical Code" and such parts of the "National Electrical Safety Code" as apply to power switchboards. Mats, railings, screens, etc., which are external to the switchboard, but which may be required to meet these codes for installed switchboards will not be furnished by the Company. The Purchaser will be responsible for specifying any requirements which are not covered by these codes.

DELIVERY. The delivery of this apparatus is contingent upon receipt of complete information from the Purchaser, necessary to complete the Company's designs. When the manufacture and shipment of the board are dependent upon the Purchaser's approval of drawings of switchboard and structure arrangement before assembling, the Company will not be responsible for delays caused by the failure of the Purchaser to give such approval promptly. The time required for obtaining the Purchaser's approval, as well as for making any changes in drawings or apparatus, will be added to the time required for delivery. Delivery date will be extended where the Company fails to receive, promptly, drilling templates, connection diagrams or outline drawings covering apparatus not of the Company's manufacture, which has been specified by the Purchaser.

Reference
Number

(10001 *Continued*) (Adopted Standard 11-17-1920.)

PACKING FOR SHIPMENT. Unless otherwise specified, prices named in this proposal include packing for shipment by rail, only.

CALIBRATION. All indicating and curve drawing instruments, watthour meters, relays and tripping devices are calibrated before shipment from the Company's Works, and any subsequent calibration shall be at the expense of the Purchaser.

DRAWINGS. The Company will furnish with the switchboard three paper prints of such standard drawings of detail apparatus, or such other instructions as are necessary, in connection with the installation and operation, and, also, three paper prints of front view drawings and wiring diagrams and such other drawings or photographs as may be required and are specified below:

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In case it shall be necessary for the Company to make or furnish drawings not included or classified in this proposal, such drawings will be charged to the Purchaser, and the Purchaser agrees to pay such additional charge.

The details of drawings to be furnished as a part of this proposal will be based upon information contained herein. Should it be necessary for the Company to make any alteration or modification of the drawings herein described, due to changes made or requested by the Purchaser, or due

Reference
Number

(10001 *Continued*)

to additional information furnished by Purchaser after signing this proposal, such changes or alterations will be charged to the Purchaser, and the Purchaser agrees to pay such additional charge.

(Adopted Standard 11-17-1920.)

(10002) Application of Switching Devices.

Switching devices applied on or operated from Power Switchboards shall be of a rated capacity at least as great as the maximum rated one hour (or more) overload current of the apparatus that the switching devices will be required to control.

(Adopted Standard Minimum Limits 11-17-1920.)

(10003) Application of Ground Detectors.

The standard practice in furnishing ground detectors on power switchboards shall be as follows:

On voltages up to and including 300, A. C. or D. C. lamps or volt meters shall be used. Above 300 volts, static or glower type ground detectors shall be used, except that up to and including 750 volts, lamps or voltmeters connected to ground through push buttons are permissible.

(Adopted Standard 11-17-1920.)

(10005) Application of Field Switches.

Field switches used with power switchboards shall be two pole remote control manually or electrically operated.

(Recommended Practice 11-17-1920,
Effective 1-1-1921.)

(10007) Standard Synchronizing Practice.

The use of lamps in synchronizing is not recommended, but where used, synchronizing "dark" shall be the standard practice.

(Adopted Standard 6-7-1921,
Effective 1-1-1922.)

Reference
Number

(10030) Panel Materials and Finishes.

The standard material for all power switchboard panels where the apparatus mounted on them depends on the material of the panels for insulation shall be black oil finished or dull black finished slate. Where necessary for insulation on voltages above 750, slate panels shall be bushed.

(Adopted Standard 11-17-1920.)

(10031) Standard Panel Sizes and Bevel.

Standard power switchboard over-all panel sizes and bevels shall be as follows:

Over-All Heights	Individual Section Heights			
64 Inches	Any combination of the following standard sections:			
76 Inches	48 Inches 28 Inches			
	A		B	
90 Inches	62 Inches 28 Inches	31 Inches 31 Inches 28 Inches	or 65 Inches 25 Inches	25 Inches 45 Inches 20 Inches

NOTE—No manufacturer shall have both A and B combinations standard for 90-inch panels.

Width in Inches:—16; 20; 24; 28 and 32.
Bevel:—¼ inch, measured on face and edge of panel section.

Maximum Tolerances:—

Width, minus 1/16″ per section.
Height, plus or minus 1/16″ per section.
Thickness, plus or minus 1/16″.

(Adopted Standard 6-7-1921, Effective 5-1-1922.)

Reference Number

(10032) Standard Types of Frames and Sizes of Sills and Frames.

Standard power switchboard frames shall be constructed of pipe or angle iron of the following dimensions:

Pipe Frame:—¾ or 1¼ inch standard pipe sizes. The center line of vertical pipe to be 2½″ from rear of panel.

Angle Iron Frame:—1½ by 2½ by ¼ inches, or 1½ by 2½ by 3/16 inches standard angle iron.

Sill for Multi-Panel Switchboards:—6 inch channel, similar to Carnegie Section Index No. 7. Eight lb. per foot except that 10½ lbs. channel may be used where the manufacturer's standard bolts for foot flanges are ½ inch in diameter.

(Adopted Standard 6-7-1921, Effective 1-1-1923.)

(10033) Name Plate Markings.

The following minimum amount of information shall be given on power switchboards:

(a) Manufacturer's name and address.
(b) Manufacturer's type designation.
(c) Manufacturer's identification reference.
(d) Rated Amperes.
(e) Rated Volts.

(Adopted Standard 6-7-1921.)

POWER SWITCHING EQUIPMENT

Rules Applying to Oil Circuit Breakers, Disconnecting Switches, Horn Gap Switches and Bus Bar Supports

Reference Number

(10100) RATING STANDARDS.

(10101) Basis of Rating.

Oil Circuit Breakers, Disconnecting Switches, Horn Gap Switches and Rear Connected Bus Bar Supports shall be rated in R.M.S. amperes based on the permissible observable temperature rise of 30° C. above ambient of 40° C. in accordance with Rule 721 of the A. I. E. E. (1918 Revision).

Additional ratings may be given on disconnecting switches and horn gap switches on the basis of a 20° C. rise.

The temperature rise of the connections to the oil circuit breaker or switch or rear connected bus bar supports shall not be greater than the above.

(Adopted Standard 5-23-1919,
Modified 11-17-1920.)

(10102) Ambient Temperature.

Power Club Rules 1060 and 5002 shall be followed, except that for oil circuit breakers the ambient temperature shall be determined by taking the average of the readings of three thermometers placed as follows: One twelve inches above, one twelve inches below, and one midway but twelve inches from the breaker as installed.

(Adopted Standard 5-23-1919.)

(10103) Basis of Voltage Rating.

Oil circuit breakers, disconnecting switches, horn gap switches and bus bar supports shall be rated in R.M.S. volts based on a dielectric test in accordance with Rules 722 and 726 of the A. I. E. E. (1918 Revision).

(Adopted Standard 5-23-1919,
Modified 11-17-1920.)

Reference Number

(10104) Rated Interrupting Capacity.

Oil circuit breakers shall be rated in R.M.S. amperes interrupting capacity in accordance with Rule 720 Standardization Rules of the A. I. E. E. (Revision of 1918) as follows:

"By interrupting (breaking or rupturing) capacity is meant the highest R.M.S. current at normal voltage which the device can interrupt under prescribed conditions at stated intervals a specified number of times."

The "stated intervals" and "specified number of times" at a given current and voltage determine the duty imposed upon a breaker. The duty shall be assumed to be that the breaker will interrupt its rated R.M.S. current two times at a two-minute interval and then be in condition to be closed and carry its rated current until it is practical to inspect it and make necessary adjustments.

The "prescribed conditions" include the stored electro-static and magnetic energy of the system, re-establishment of an arc under transient voltage conditions and other variable conditions. These influences are considered as not differing widely in average systems and are to be taken into account in the factor of safety employed in the rating of breakers.

In addition a momentary carrying capacity in R.M.S. amperes shall be given.

NOTE—The National Electric Light Association, through its Subcommittee on Switchboards, is taking an active interest in this subject and proposes to submit data and suggestions to manufacturers for their guidance in determining modifications of and additions to the above interrupting capacity rule.

(Adopted Standard 5-23-1919.)

(10105) Name Plate Markings.

The following minimum amount of information shall be given on name plates of all oil circuit breakers (other than industrial types), disconnecting switches and horn gap switches:

(a) Manufacturer's Name and Address.

(b) Manufacturer's Type and Designation Number.

Reference
Number

(10105 *Continued*)

(c) Rated Amperes.

(d) Rated Volts.

(e) Frequency, if other than 60 cycles.

Where the operating mechanism is not included in an oil circuit breaker designation, separate name plates shall be provided on this mechanism, giving manufacturer's designation of mechanism and also of coils, if any.

NOTE.—See also Reference Number 10130a.)

(Adopted Standard 6-7-1921.)

STANDARD AMPERE RATINGS.

(10120) Rated Frequency.

Ratings, not otherwise specified, of oil circuit breakers, disconnecting switches, horn gap switches and rear connected bus bar supports are understood to be at 60 cycles. At and above 600 amperes, both 25 cycle and 60 cycle ratings may be given.

(Adopted Standard 5-23-1919,
Modified 11-17-1920.)

(10121) Standard 60 Cycle Ratings.

Existing oil circuit breakers, disconnecting switches, horn gap switches and rear connected bus bar supports so far as possible, and all new designs (other than industrial type oil circuit breakers) shall have the following ampere ratings at 60 cycles:

Ampere Ratings at 60 Cycles.

200	1600	5000*
400	2000	6000
600	2400	
800	3000	
1200	4000	

*This rating applies to disconnecting switches only.

(Adopted Standard 5-23-1919,
Amended 11-17-1920.)

Reference
Number

(10122) Standard 25 Cycle Ratings.

Oil circuit breakers, disconnecting switches, horn gap switches and rear connected bus bar supports for 25 cycle service shall be standard 60 cycle equipment given its corresponding rating at 25 cycles.

(Adopted Standard 5-23-1919,
Amended 11-17-1920.)

(10123) Rated Momentary Carrying Capacity.

Oil circuit breakers, disconnecting switches, horn gap switches and rear connected bus bar supports shall be rated in R.M.S. amperes, which they will safely carry for five seconds and may in addition be given a rating for one second.

(Recommended Practice 11-17-1920.)

(10130) Standard Voltage Ratings.

The standard voltage ratings of oil circuit breakers, disconnecting switches, horn gap switches and bus bar supports, up to 37,000 volts, inclusive, shall be as follows:

Maximum Rating—a.

750	15000
2500	25000
4500	37000
7500	

Above 37,000 volts, the standard voltage ratings corresponding to standard normal system voltages shall be as follows:

Standard Rating (Normal Voltage)—b.

44000	132000
66000	154000
88000	220000
110000	

*NOTE—It is recognized that until further notice, 50,000 and 73,000 volt maximum rated oil circuit breakers, disconnecting switches, horn gap switches and bus bar supports, may be supplied for systems up to 50,000 volts and 73,000 volts respectively.

Reference
Number

(10130 ***Continued*)**

(a) Maximum rated oil circuit breakers, disconnecting switches, horn gap switches and bus bar supports shall have name plates marked "———volts Maximum Rating." Standard (Normal) rated oil circuit breakers, disconnecting switches, horn gap switches and bus bar supports, shall have name plates marked "———volts Normal Rating."

(b) Standard (normal) rated oil circuit breakers, disconnecting switches, horn gap switches and bus bar supports may be applied on systems having a maximum voltage not more than 5% above the name plate rating, but dielectric strength tests shall be based on the name plate rating. (Applications at 5% above the name plate rating may not be made in the case of maximum rated oil circuit breakers, disconnecting switches, horn gap switches and bus bar supports.)

NOTE—The use of the word "pressure" instead of "voltage" is recognized as optional.

(Adopted Standard 6-7-1921,
Effective 1-1-1922.)

(10132) Protection from Voltage Surges.

The standard voltage ratings of oil circuit breakers, disconnecting switches, horn gap switches and bus bar supports are based on the understanding that if such apparatus is connected to aerial transmission lines, such lines shall not be provided with insulators having a wet arc over voltage in excess of the dielectric tests of the breakers unless such breakers are adequately protected by lightning arrester equipment.

(Adopted Standard 6-7-1921.)

Reference
Number

Rules Applying to Oil Circuit Breakers Only.

(10140) Voltage Ratings.

Published ampere interrupting capacity ratings shall be at standard voltages stated in Reference Number 10130 and, in addition, at the following intermediate voltages:

6000 12000 30000

Interrupting capacities at intermediate voltages are obtained by inverse proportion related to the next higher listed voltage.

(Adopted Standard 5-23-1919.)

SELECTION AND APPLICATION.

(10150) Panel and Panel Frame Mounting.

(a) Panel mounting oil circuit breakers shall be limited to 800 amperes maximum rating, and panel frame mounting oil circuit breakers shall be limited to 2000 amperes maximum rating.

(b) Panel and panel frame mounting oil circuit breakers shall be limited to 2500 volts maximum rating. (Adopted Standard 5-23-1919.)

(10151) Series Trip Coils.

Series trip coils in panel or panel frame mounting oil circuit breakers shall be limited as follows:

(a) Maximum current rating, 200 amperes.

(b) Maximum voltage rating of coils, 750 volts.

(Adopted Standard 5-23-1919.)

(10153) Selection of Circuit Breakers for "Y" Systems.

In general, oil circuit breakers shall be applied on the basis of the full line or delta voltage of the system. However, on systems having full line voltage of 110,000 volts or over, with the full understanding and agreement of the Purchaser, alternatives may be given on the basis of voltage to ground when the system is "Y" connected with one

Reference
Number

(10153 *Continued*)

end of the single phase transformer windings permanently connected to the core and case, which are suitably grounded and with the oil circuit breakers so located and connected, that whether closed or opened they will not be energized by transformers, the neutrals of which are not solidly grounded. When applying oil circuit breakers on the basis of voltage to ground, the circuit breaker frame must be grounded and the dielectric dry test shall be 3.1 times voltage to ground, plus 2000, and the dielectric wet test shall be 2.73 times voltage to ground, plus 1000. (Adopted Standard 6-7-1921.)

(10154) Information Required for Selecting Oil Circuit Breakers.

When the manufacturer is required to select oil circuit breakers suitable for application on the purchaser's system, the information to be required from the purchaser shall be as follows:

DATA SHEET
INFORMATION SHEET FOR OIL CIRCUIT BREAKER SELECTION.

When the......................................Company is called upon to select oil circuit breakers for application on a particular system, the following data
information is required:

(1) Indicate the required circuit breakers on Blank No. 1 (when Purchaser specifies the required interrupting capacity and momentary carrying capacity and does not want the Company to check it data
information paragraphs No. 2 to No. 7, inclusive, need not be supplied).

(2) Furnish a map of the complete system, showing generators, transformers, generator stations, sub-stations, transmission lines, "ties" with other transmission systems, etc.

(3) Furnish a wiring diagram for each generating station, showing generators, main bus bars, connections, reactors and transformers. Mark the exact location of proposed oil circuit breakers, and additional data
information on Blank No. 2.

Reference Number

(10154 *Continued*) (Adopted Standard 6-7-1921.)

(4) Furnish a list of overhead transmission lines, underground cable lines and tie lines with other systems on Blank No. 3.

(5) Furnish a wiring diagram for each sub-station, showing synchronous apparatus, converters, transformers, main bus bars, connections and reactors. Mark the exact location of proposed oil circuit breakers. Furnish a list of sub-station equipment and additional data information on Blank No. 4.

(6) State the approximate total Kv-a rating of synchronous apparatus on the system not listed under No. 5.

(This is intended to include apparatus in the station of Power Company's customers)................Kv-a.

(7) State the scheme of relay operation and whether the relays to be used are instantaneous, inverse, inverse definite or definite time. Also state the minimum time setting to be used.

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OIL CIRCUIT BREAKER SELECTION BLANK NO. 1.

Proposed Oil Circuit Breakers.

Location	No. of Breakers	Continuous ampere capacity, including overloads for one hour or more	Frequency	Operating voltage of Circuit	Poles and Throw	*Type of Mounting	**Method of Control and Control Voltage for Elec. Oper. Breakers	***Method of Trip	‡Required Interrupting Capacity in Amperes	‡Required Momentary (1 to 5 Seconds) Carrying Capacity

NOTE—State altitude of each breaker location if more than 3000 feet.

Reference Number

(10154 *Continued***)** (Adopted Standard 6-7-1921.)

*In addition, state whether indoor or outdoor. Indicate by note any special conditions applying to the mounting of individual breakers.

**If manually operated, state "Manual" in blank. Standard Voltage range for storage battery control is as follows. If standard range does not apply, state specifically for each breaker the required range.

(Manufacturer shall state standard range.)

***Indicate method of tripping by following keys and follow the key letter by a number to indicate the number of legs on which current transformers are to be used.

Key Letter	Method of Tripping.
A	Non-Automatic.
B	A. C. Series Trip. (State number of coils.)
C	Current Transformers with A. C. Trip coil—no relay.
D	Current Transformers with A. C. shunt trip coil and circuit closing relays.
E	Current Transformers with A. C. trip coil and circuit opening relays.
F	Current Transformers with D. C. trip coil and relays.
G	(Any other method than above.) Describe in full.

#These columns should not be filled in if purchaser wants the Company to determine the required interrupting capacity and momentary carrying capacity from data / information called for on blanks No. 2 to 4, inclusive.

Reference Number

(10154 *Continued*) (Adopted Standard 6-7-1921.)

The duty on which the standard interrupting capacity ratings of the..................................Company's oil circuit breakers are based assumes that the breaker will interrupt a circuit two times at a two-minute interval, and then be in condition to be closed and to carry full rated normal current until it can be inspected. Any practice differing from this duty cycle should be the basis of a special report to the Company.

OIL CIRCUIT BREAKEER SELECTION BLANK NO. 2.

GENERATING STATION.......................................

WIRING DIAGRAM (DESIGNATION)............

GENERATORS

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Gen. Rating in Kv-a	......	......	......	......	......	......
Power Factor............	......	......	......	......	......	......
Voltage	......	......	......	......	......	......
Frequency	......	......	......	......	......	......
Speed	......	......	......	......	.....	......
Manufacturer	......	......	......	......	......	......
Serial No.	......	......	......	......	......	......
*If Neutral is Grounded, State Resistance in Ohms in Ground Connection	......	....	.....	......	......	......
Prime Mover.............	......	......	......	......	......	......
Per Cent Generator Reactance Based on Kv-a	......	......	......	......	......	......

State Number of phases and number of wires..........

**State which generators are run during condition of maximum load...

State number of generators grounded at any one time and the corresponding equivalent resistance ....

Are voltage regulators used?..

Reference Number

(10154 *Continued*) (Adopted Standard 6-7-1921,

***POWER TRANSFORMERS

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5
Low Voltage..............	....	....	....	....	....
High Voltage..............	....	....	....	....	....
Rating	....	....	....	....	....
Connection (Y or Delta)	....	....	....	....	....
*If Neutral is Grounded, State Resistance in Ohms in Ground Connection	....	....	....	....	....
Per Cent Transformer Reactance	....	....	....	....	....
Based on Kv-a......	....	....	....	....	....

State number of transformers grounded at any one time and the corresponding equivalent resistance....

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*If neutral is grounded through a reactor, state reactance in ohms and nature of scheme.

**Interrupting capacity should be based on worst condition (maximum connected generator capacity), but if alternative is wanted on the basis of a less number of generators, state the conditions accordingly.

***If circuit breakers are to be applied on the secondary of station service transformers, state the per cent reactance and Kv-a of such transformers separately.

MISCELLANEOUS APPARATUS

Bus Reactor Per Cent Reactance....................................
Based on Kv-a...

Feeder Reactor Per Cent Reactance..............................
Based on Kv-a.......................................

Reference Number
(10154 *Continued*) (Adopted Standard 6-7-1921,

OTHER EQUIPMENT AND CHARACTERISTICS

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OIL CIRCUIT BREAKER SELECTION BLANK NO. 3.

TRANSMISSION LINES...

WIRING DIAGRAM (DESIGNATION)...........

*Designation of Line	Rating or ampere capacity	Voltage	Frequency	Length in Miles	Size of Conductor	**Material of Conductor	***Spacing	Arrangement of Conductors

*Refer to Map of System.

**If underground cable, give number of conductors in cable and type of insulation, thickness of insulation on conductor and belt.

***State type of Insulators used and their arc over voltage (wet and dry)..

Reference Number

(10154 *Continued*) (Adopted Standard 6-7-1921.)

***The standard voltage ratings of oil circuit breakers are based on the understanding that if the breakers are connected to aerial transmission lines, such lines shall not be provided with insulators having a wet arc over voltage in excess of the dielectric tests of the breakers unless such breakers are adequately protected by lightning arrester equipment.

OIL CIRCUIT BREAKER SELECTION BLANK NO. 4.

SUB-STATION.................... NUMBER....................

WIRING DIAGRAM (DESIGNATION)...........

POWER TRANSFORMERS

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5
High Voltage............	....	....	....	....	....
Low Voltage...........	....	....	....	....	....
Rating	....	....	....	....	....
Connection (Y or Delta)	....	....	....	....	....
*If neutral is Grounded, State Resistance in Ohms in Ground Connection	....	....	....	....	....
Per Cent Transformer Reactance Based on Kv-a......	....	....	....	....	....

State number of transformers grounded at any one time and the corresponding equivalent resistance

*If Neutral is grounded through a reactor, state reactance in ohms and nature of scheme.

(Adopted Standard 6-7-1921.)

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Reference Number

(10154 *Continued***)** (Adopted Standard **6-7-1921.)**

GIVE FULL DETAILS OF MOTOR GENERATOR SETS, SYNCHRONOUS CONVERTERS OR SYNCHRONOUS CONDENSERS IN SUB-STATION.

	Unit 1	Unit 2	Unit 3	Unit 4
Apparatus				
Rating				
Voltage				
Frequency				
Manufacturer				
Serial Number				
Per Cent Reactance as A. C. Generator				
Based on Kv-a				

Disconnecting Switches

Reference
Number

(10300) MOUNTINGS.

(10301) Front and Rear Connections.

Front connections shall be considered standard for all ratings.

Rear connections of studs shall be considered standard up to and including 25,000 volts.

All combinations of front and rear connections shall be considered special.

(Adopted Standard 11-17-1920,
Effective 1-1-1921.)

(10302) Indoor 2500-Volt Switch Bases.

Indoor 2500-volt disconnecting switches shall be considered standard when mounted on flat insulating bases, equal to, or better than marble.

(Adopted Standard 11-17-1920.)

(10303) Rear Connected Switch Studs.

Rear connected disconnecting Switches shall be considered standard with the following studs:

Round studs up to and including 1200 amperes.

Round or laminated studs at 1600 and 2000 amperes.

Laminated studs at 2400 amperes and above.

(Adopted Standard 11-17-1920.)

RECOGNIZED DEPARTURES

From the Standards of The Electric Power Club

Reference Number

(20000) GENERAL.

It is recognized by members of The Electric Power Club that the advance of the industry, the progressive development of the art of manufacturing electrical apparatus, and the rewards to which individual members are properly entitled as the result of initiative, research and invention, must not be retarded or curtailed by adopted standards to which the majority still subscribe; that during a period of change or progressive development honest differences of opinion may arise over a proposed change or departure from an existing standard; and that where there is reasonable evidence that such change is in the public interest, it is desirable that, while its merits are being generally demonstrated, the departure be formally recognized by The Electric Power Club as the authoritative body controlling the standardization of Electrical Apparatus.

In accordance with the above paragraph the following departure from standard practices and recommendations of The Electric Power Club has been formally recognized by The Electric Power Club:

1. 50° open type continuous duty fractional horse power for general purposes.

For standard temperature ratings of The Electric Power Club see Reference Number 5303.

(Recognized 5-23-1919.)
(Amended 11-15-1921.)

INDEX

Rules pertaining to the design, manufacture or performance of any piece of power or control apparatus are indexed under the apparatus heading.

All Definitions are indexed under "Definitions" irrespective of the apparatus to which they apply.

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C

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C

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Rules pertaining to the design, manufacture or performance of any piece of power or control apparatus are indexed under the apparatus heading.

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ADDENDA

The following sheets contain certain pertinent information relative to Member Companies of The Electric Power Club. There is one page for each company, and the names are arranged alphabetically.

Automatic Switch Company

154 GRAND STREET

NEW YORK, N. Y.

OFFICERS

DAVID H. DARRIN . . . . PRESIDENT

APPARATUS MANUFACTURED

Direct and Alternating Current Automatic Motor Starters and Switches

Elevator Controllers

Printing Press Controllers

Machine Tool Controllers

Organ Controllers

Vacuum Cleaner Controllers

Speed Regulating Controllers

Hoist and Conveyor Controllers

Pump Controllers

Compressor Controllers

Pressure, Vacuum and Temperature Regulating Switches

Magnetically Operated Valves and Damper Movements

Lifting Magnets

Elevator Safety Switches

Refrigerating Machine Controlling Devices.

Dead Front Control Panels for Wireless Generating Sets.

Bell Electric Motor Company

BELL TERMINAL

GARWOOD, N. J.

OFFICERS

A. C. BELL	PRESIDENT
T. R. BELL	VICE-PRESIDENT
A. L. BELL	SECRETARY

APPARATUS MANUFACTURED

Single-phase — Repulsion — Induction Motors
Polyphase Motors (Squirrel Cage and Compensated type)
Direct Current Motors and Generators

BRANCH OFFICES

NEW YORK CITY	**30 Church Street**
CHICAGO, ILLINOIS	**Monadnock Building**

NOTE: SPECIAL ARRANGEMENTS CAN BE MADE COVERING THE SALE OF THE ABOVE APPARATUS WITH MEMBER COMPANIES.

Century Electric Company

Main Office and Works

19th, Pine to Olive Streets
ST. LOUIS, MO.

OFFICERS

E. S. PILLSBURY .... President
S. M. JONES .... Vice-President
R. J. RUSSELL .... Vice-President and Secretary
J. L. WOODRESS .. Sales Manager and Assistant Secretary
JOHN HERGET .... Treasurer
B. M. WHITTEMORE .... Assistant Treasurer

APPARATUS MANUFACTURED

Century — *Single Phase Alternating Current Motors*

Century — *Polyphase Alternating Current Motors*

"Invincible" — *Split Phase Alternating Current Motors*

Century — *Fan Motors Alternating Current and Direct Current*

Sales Offices and Stocks at

ATLANTA
BOSTON
CHATTANOOGA
CHICAGO
CINCINNATI
CLEVELAND
DALLAS
DENVER
DES MOINES
DETROIT
GREENSBORO
INDIANAPOLIS
KANSAS CITY
LOS ANGELES
MINNEAPOLIS
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURG
PORTLAND
ROCHESTER
SALT LAKE CITY
SAN FRANCISCO
SEATTLE
SPOKANE

Montreal, Toronto, Vancouver, Winnipeg, Canada.

Chandeysson Electric Company

ST. LOUIS, U. S. A.

OFFICERS

P. I. CHANDEYSSON............President
W. C. FORDER....................Treasurer
A. C. F. MEYER..................Secretary

APPARATUS MANUFACTURED:

Polyphase Alternating Current Motors.

Chandeysson "Special" Direct to Shaft Connected Sewing Machine Motors.

Direct Current Motors, Constant Speed.

Direct Current Generators.

Direct Current Motors, Adjustable Speed.

Motor Generator Sets.

Electrolytic Dynamos.

Synchronous Converters.

The Dayton Fan & Motor Co.

Main Office and Factory

DAYTON, OHIO.

OFFICERS

Maurice D. Larkin.......................President

Ernest Boehme ....Secretary

APPARATUS MANUFACTURED

Desk Fans—A. C. and D. C.

Ceiling Fans—A. C. and D. C.

Fraction H. P. Motors—A. C. and D. C.

Repulsion Induction Motors.

Special small motor applications.

Diehl Manufacturing Company

ELIZABETH, N. J.

OFFICERS

HJALMAR HERTZ	President
F. A. PARK	Vice-President
C. H. MORRELL	Secretary and Assistant Treasurer

APPARATUS MANUFACTURED

Direct Current Power Apparatus, including Motors, Generators, Dynamometers, Automobile Motors, Adjustable Speed Motors and many classes of Special D. C. Apparatus.

Alternating Current Poly Phase Induction Motors up to 50 H. P.

Direct and Alternating Current Desk and Ceiling Fans and Exhaust Wheels.

Interchangeable Direct and Alternating Current Fractional Horse Power Motors.

BRANCH OFFICES

NEW YORK . .	149 Broadway
PHILADELPHIA . .	1305 Race Street
CHICAGO . .	1017 W. Jackson Boulevard
BOSTON . .	566 Atlantic Avenue

The Electric Products Company

1745 Clarkstone Road

CLEVELAND, OHIO

OFFICERS

MAXWELL R. BERRY........................President
E. H. BRIDGE..............................Vice-President
MAXWELL R. BERRY........................Treasurer
T. J. WILLIAMS..............................Secretary

APPARATUS MANUFACTURED

Motor-Generators for Battery Charging.
Rheostats for Battery Charging.
Direct Current Vehicle Motors.
D. C. and A. C. Power Switchboards.
Grid Resistors.

BRANCH OFFICES

NEW YORK . . . . 30 Church Street
PITTSBURGH . . . 518 State Bldg.

The Glow Electric Company

CINCINNATI, OHIO.

Alex. Glowicki .... President

APPARATUS MANUFACTURED

Portable Electric Drills

Ball Bearing Bench Grinders

Ball Bearing Floor Grinders

Ball Bearing Bench Buffers or Polishing Lathes

Ball Bearing Floor Buffers or Polishing Lathes

Represented in All Principal Cities.

Goodman Manufacturing Co.

CHICAGO, ILL.

OFFICERS

FRANK S. WASHBURN............President
CHAS. H. STRAWBRIDGE....Vice-President
CHAS. A. PRATT..............Vice-President
FRED H. JOHNSTON..Secretary & Treasurer

APPARATUS MANUFACTURED

Electric Coal Cutting Machinery
Electric Locomotives

BRANCH OFFICES

NEW YORK CITY	511 Fifth Avenue
PITTSBURGH, PA. . . .	Farmers Bank Bldg.
CINCINNATI, OHIO . . .	Union Trust Bldg.
CHARLESTON, W. VA. . .	Union Building
ST. LOUIS, MO.	Boatmen's Bank Bldg.
DENVER, COL.	Boston Bldg.
BIRMINGHAM, ALA. . . .	Brown-Marx Bldg.

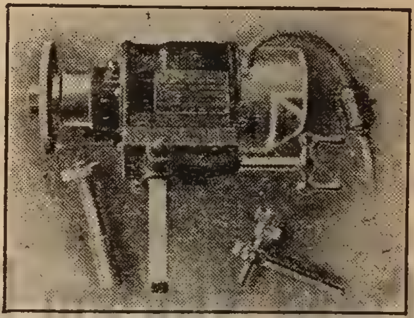
The Hisey Wolf Machine Company

Colerain and Marshall Aves.

CINCINNATI, OHIO.

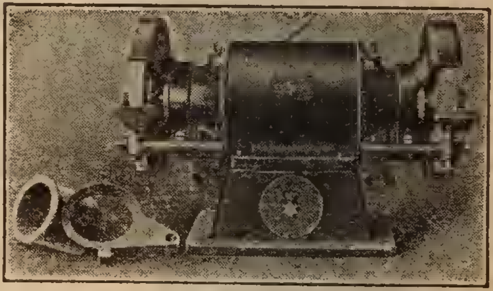
APPARATUS MANUFACTURED.

Portable Electric Tool Post Grinders, ¼ and ½ H.P. size, with and without Slide Adjustment.



Portable Electric Drills for Direct Current, Alternating Current, also Universal motor machines for operation on Direct Current and Alternating Current.

Bench and Floor Grinders. Made in ½, 1, 2, 3, 5 and 10 H.P. sizes.



Also manufacturers of Portable Electric Bench and Floor Buffing Lathes, Surface Grinders, Angle Plate Grinders, Screw Driver, Scotch Radial Drills, Heavy Duty Drills and Reamers.

The Holtzer-Cabot Electric Co.

ROXBURY, BOSTON, MASS.

OFFICERS

C. W. HOLTZER	President
EDWIN R. HARDING	Vice-President
W. S. KEMP	Secretary and Treasurer
T. W. NESS	General Manager
W. E. HASELTINE	Ass't General Manager

APPARATUS MANUFACTURED

Fractional horse-power Direct Current Motors; Fractional horse-power single- and Poly-phase Alternating Current Motors; Direct Current Motors to 30 H. P.; Direct Current Generators to 20 K. W.; Polyphase Alternating Current Motors, 1 to 30 H. P.; Motor Generators; Dynamotors; Reversed Rotaries; Plating Dynamos; Buffing and Grinding Motors; Dental and Jewelers' Lathe Motors; Gas Engine Generating Units; Multicycle Motor Generator Sets; Alternating Current Magnetos; Magneto Tachometers; Wireless Motor Generators.

BRANCH OFFICES

CHICAGO	6161 South State Street.
BALTIMORE	1104 Union Trust Bldg.
PHILADELPHIA	112 So. 16th St.
NEW YORK	101 Park Avenue
DETROIT	952 Book Bldg.
MINNEAPOLIS	Metropolitan Life Bldg.

The Imperial Electric Company

AKRON, OHIO.

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KYLE ROSS	Vice-President
J. A. W. SEIFERT	Treasurer
C. S. McQUEENEY	Secretary
GUY S. WORTLEY	General & Sales Manager

APPARATUS MANUFACTURED

ALTERNATING CURRENT	*DIRECT CURRENT*
Squirrel Cage Motors	*Standard Interpoled Motors*
Slip Ring Motors	*Adjustable Speed Interpole Motors*
Motor Generator Sets	*Standard Voltage Generators*
	Low Voltage Generators

Polyphase Motors are built in sizes from ½ HP to 100 HP in all voltages and cycles. Direct Current Machines are built in ratings from ½ HP to 75 HP in all voltages.

This equipment is built for all classes of service.

BRANCH OFFICES:

CHICAGO	130 North Wells Street
NEW YORK	253 Broadway
PITTSBURGH	210 Second Avenue, South
COLUMBUS	311 Citizens Bank Building
CINCINNATI	138 West 3rd Street
PHILADELPHIA	The Bourse
BOSTON	164 Federal Street

The Ironton Engine Company

IRONTON, OHIO.

OFFICERS

E. B. HETZEL	President
A. H. MITTENDORF . . .	Vice-President
E. H. ALLFREE . . .	Sec'y and Gen. Mgr.
E. O. MARTING	Treasurer

PRODUCT

Storage Battery Locomotives.

Combination Storage Battery and Trolley Locomotives.

Motor Generator and Rheostat Switchboards.

BRANCH OFFICES

PITTSBURGH	561 Union Arcade Bldg.
PHILADELPHIA	511 Widener Bldg.
CHICAGO	Caxton Bldg., 508 So. Dearborn St.
DENVER	570 Gas and Electric Bldg.
COLUMBUS, OHIO	409 Weber Road
LOUISVILLE, KY	1110 Starks Bldg.
HUNTINGTON, W. VA	1016 Robson-Prichard Bldg.
BIRMINGHAM, ALA	1308 American Trust Bldg.
SEATTLE WASH	808 Post St.

Northwestern Mfg. Company

480-82 CLINTON ST.

MILWAUKEE, WIS.

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JOHN F. HARPER	Vice-President
FREDERICK W. ELLS	Secretary
WM. STARK SMITH	Treasurer

APPARATUS MANUFACTURED

Direct Current Motors and Generators

Polyphase Alternating Current Motors and Generators

Coke Oven Pressure Regulators

Special Electrical Machinery

Boiler Draft Control

BRANCH OFFICES

CHICAGO........................	30 No. Michigan Blvd.
PHILADELPHIA......................	208 Fuller Bldg.
NEW YORK.........................	145 W. 18th St.
DETROIT........................	715 Dime Bank Bldg.
GRAND RAPIDS.............	637 Michigan Trust Bldg.
NEW ORLEANS.............	721 Whitney Central Bldg.

Reliance Electric & Engineering Co.

1072 Ivanhoe Road

CLEVELAND, O.

OFFICERS

C. L. COLLENS, 2d	President
H. MORLEY HITCHCOCK	Vice-President
C. V. PUTNAM	Secretary
LAWRENCE HITCHCOCK	Treasurrer

APPARATUS MANUFACTURED

DIRECT CURRENT MOTORS

Adjustable Speed

Type "AS" Armature Shifting Design

Runs at any speed and develops a constant horsepower output over any range up to 1 to 10. Smooth and gradual changes in speed are obtained by shifting the motor armature.

Type "T" Inter-pole field resistance control.

Constant Speed

Type "T" shunt or compound wound

Type "T" Inter-pole, shunt or compound pound wound

Direct Current Generators

ALTERNATING CURRENT INDUCTION MOTORS

Squirrel Cage Rotor

Wound rotor with slip rings

High Resistance Squirrel Cage Rotor

TRADE NAME, "RELIANCE"

BRANCH OFFICES

CHICAGO	343 S. Dearborn St.
NEW YORK	52 Vanderbilt Ave.
PHILADELPHIA	Pennsylvania Bldg.
PITTSBURGH	House Bldg.
BOSTON	200 Devonshire St.
DETROIT	401 Sun Bldg.
CINCINNATI	1700 Union Trust Bldg.

The Temco Electric Motor Co.

LEIPSIC, OHIO.

TEMCO
Trade Mark

OFFICERS

J. E. WERNER	President
R. A. PRENTISS	Sec'y-Treas.

APPARATUS MANUFACTURED.

Portable Electric Drills.

Grinders and Buffers.

Small Motors.

Wagner Electric Mfg. Co.

ST. LOUIS, MO.

APPARATUS MANUFACTURED

Single-phase Motors; Polyphase Motors; Distribution and Power Transformers; Portable and Switchboard Instrument Transformers; Rectifiers; Converters for changing alternating current to direct for Motion Picture Projection and Battery Charging; Automobile Engine Starters; Battery Ignition; Electric Automobile Motors.

*ATLANTA, Ga.	116 West Peachtree Avenue
AUSTRALIA	127-137 Elizabeth St., Melbourne
*BALTIMORE	2018 N. Charles St.
*BOSTON	342 Newbury St.
BRAZIL	44 Rue De Boa Vista, Sao Paulo
BRITISH INDIA	Bombay No. 4, India
BRITISH S. AFRICA	43 Anderson St., Johannesburg
*BUFFALO	16 Carlton St.
*CHICAGO	918 S. Michigan Blvd.
*CINCINNATI	20 East 9th St.
*CLEVELAND	701 Union Bldg.
CUBA	Murallo 40, Havana
*DALLAS	2007 S. Ervay St.
*DENVER	1633 Tremont St.
*DETROIT	5919 Woodward Ave.
EGYPT	Alexandria, care E. R. Ballis & Brother
*INDIANAPOLIS, IND.	922 N. Pennsylvania Ave.
JAPAN	75 Main Street, Yokohama
*KANSAS CITY, MO.	905 E. 15th St.
*LOS ANGELES	1320 South Grand Ave.
*MEMPHIS, TENN.	1076 Union Ave.
MEXICO	San Juan De Letran 5, Mexico City
*MILWAUKEE	501 Broadway
*MINNEAPOLIS	1310 Nicollet Ave.
MONTREAL	420 Power Bldg.
*NEW YORK	50 Church St.
*OMAHA	3102 Sherman Ave.
*PHILADELPHIA	1632 Sansom St.
*PITTSBURGH	530-534 Fernando St.
*PORTLAND, OREGON	327 Flanders St.
*SALT LAKE, UTAH	59 W. Broadway
*SAN FRANCISCO	159 New Montgomery St.
*SEATTLE	531 1st Avenue S.
SIAM	Bangkok. Siam Electric Company
SPAIN	Paseo De Gracia 20, Barcelona, Spain
*ST. LOUIS, MO.	3029 Locust St.
SPRINGFIELD, MASS.	318 Main St.
TOLEDO	1077 Lincoln Ave.
*TORONTO	217 Dundas St., E.

*These Offices have fully equipped service stations.